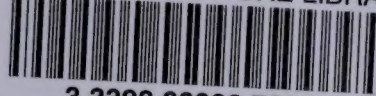
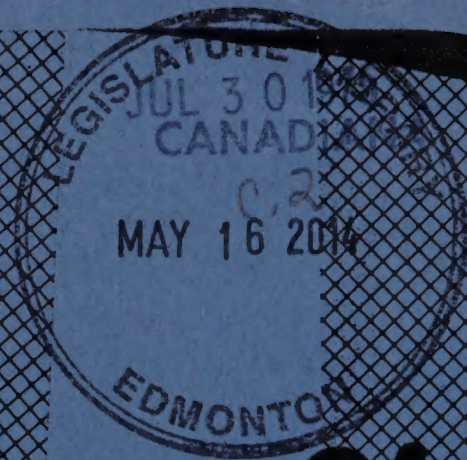


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# Preliminary Biological Survey Of Waters in the Birch Mountains

by W. R. Turner




11 Alberta

36 SURVEY REPORT NO. 3

Alberta Fish and Wildlife Division

26 FISHERIES SECTION





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# TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

## A PRELIMINARY BIOLOGICAL SURVEY

LAKE LAKE

Introduction

OF WATERS IN THE

Morphology

Water Chemistry

BIRCH MOUNTAINS, ALBERTA

Bottom Fauna

Fish Fauna

Discussion and Conclusion

MIXIMA RIVER

NAMUR LAKE

Introduction

Morphology

by

Physical and Chemical Features

Bottom Fauna

William R. Turner

Plankton

Fish Fauna

Fishery Biologist

Discussion & Conclusions

UNNAMED STREAM ENTERING NAMUR LAKE

NAMUR RIVER

CAMBER LAKE

Introduction

Morphology

Physical and Chemical Features

Bottom Fauna

Fish & Wildlife Division

Plankton

Department of Lands and Forests

Fish Fauna

April 1968

Discussion and Conclusions

SEPARATED STREAM ENTERING CAMBER LAKE

WILSON RIVER

BEAVER LAKE (79 - 16 - WL)

Introduction







## TABLE OF CONTENTS

### LIST OF TABLES

### LIST OF FIGURES

INTRODUCTION . . . . .	1
LEGEND LAKE . . . . .	3
Introduction . . . . .	3
Morphometry . . . . .	3
Water Chemistry . . . . .	4
Bottom Fauna . . . . .	4
Fish Fauna . . . . .	5
Discussion and Conclusion . . . . .	8
MIKKWA RIVER . . . . .	22
NAMUR LAKE . . . . .	30
Introduction . . . . .	30
Morphometry . . . . .	30
Physical and Chemical Features . . . . .	31
Bottom Fauna . . . . .	32
Plankton . . . . .	33
Fish Fauna . . . . .	34
Discussion & Conclusions . . . . .	37
UNNAMED STREAM ENTERING NAMUR LAKE . . . . .	53
NAMUR RIVER . . . . .	57
GARDINER LAKE . . . . .	63
Introduction . . . . .	63
Morphometry . . . . .	63
Physical and Chemical Features . . . . .	64
Bottom Fauna . . . . .	65
Plankton . . . . .	65
Fish Fauna . . . . .	66
Discussion and Conclusions . . . . .	69
UNNAMED STREAM ENTERING GARDINER LAKE . . . . .	87
ELLS RIVER . . . . .	90
UNNAMED LAKE (99 - 16 - W4) . . . . .	94
Introduction . . . . .	94





Morphometry . . . . .	94
Physical & Chemical Features . . . . .	95
Bottom Fauna . . . . .	96
Plankton . . . . .	97
Fish Fauna . . . . .	97
Discussion and Conclusions . . . . .	100
UNNAMED LAKE (100 - 15 - W4) . . . . .	116
Introduction . . . . .	116
Morphometry . . . . .	116
Physical & Chemical Features . . . . .	117
Bottom Fauna . . . . .	118
Plankton . . . . .	119
Fish Fauna . . . . .	119
Discussion and Conclusions . . . . .	122
DISCUSSION AND CONCLUSIONS . . . . .	136
RECOMMENDATIONS . . . . .	137
ACKNOWLEDGEMENTS . . . . .	137
REFERENCES . . . . .	138

I. Morphometry . . . . .	28
II. Bottom Fauna . . . . .	29
III. Physical & chemical observations . . . . .	40
IV. Water chemistry . . . . .	42
V. Plankton . . . . .	48
VI. Test net results . . . . .	53
VII. Length, weight and maturity of lake trout . . . . .	56
VIII. Length, weight and maturity of lake whitefish . . . . .	58
IX. Length, weight and maturity of tullibee . . . . .	75

UNNAMED STREAM ENTERING NARROW LAKE

I. Bottom fauna . . . . .	76
II. Water chemistry . . . . .	78
III. Lengths & weights of arctic grayling . . . . .	80

NARROW RIVER

I. Bottom fauna . . . . .	80
II. Water chemistry . . . . .	82







## LIST OF TABLES

### LEGEND LAKE

I. Morphometry . . . . .	9
II. Bottom fauna . . . . .	10
III. Water chemistry . . . . .	11
IV. Test net results . . . . .	12
V. Length, weight and maturity of lake whitefish . .	13
VI. Length, weight and maturity of northern pike . . .	13
VII. Length and weight of tullibee . . . . .	14
IX. Length, weight and maturity of longnose suckers .	14

### MIKKWA RIVER

I. Bottom fauna . . . . .	25
II. Water chemistry . . . . .	26
III. Lengths & weights of arctic grayling . . . . .	27
IV. Water chemistry - Unnamed stream entering Legend Lake . . . . .	27

### NAMUR LAKE

I. Morphometry . . . . .	38
II. Bottom fauna . . . . .	39
III. Physical & chemical observations . . . . .	40
IV. Water chemistry . . . . .	41
V. Plankton . . . . .	42
VI. Test net results . . . . .	43
VII. Length, weight and maturity of lake trout . . . .	44
VIII. Length, weight and maturity of lake whitefish . .	44
IX. Length, weight and maturity of tullibee . . . . .	45

### UNNAMED STREAM ENTERING NAMUR LAKE

I. Bottom fauna . . . . .	55
II. Water chemistry . . . . .	56
III. Lengths & weights of arctic grayling . . . . .	56

### NAMUR RIVER

I. Bottom fauna . . . . .	59
II. Water chemistry . . . . .	60







III. Lengths and weights of arctic grayling . . . . .	60
GARDINER LAKE	
I. Morphometry . . . . .	71
II. Bottom fauna . . . . .	72
III. Physical & chemical observations . . . . .	73
IV. Water chemistry . . . . .	74
V. Plankton . . . . .	75
VI. Test net results . . . . .	76
VII. Length, weight & maturity of walleye . . . . .	77
VIII. Length, weight & maturity of northern pike . . . . .	77
IX. Length, weight & maturity of lake whitefish . . . . .	78
X. Length, weight & maturity of tullibee . . . . .	78
XI. Length, weight & maturity of white suckers . . . . .	79
XII. Length, weight & maturity of longnose suckers . . . . .	79
XIII. Length, weight & maturity of perch . . . . .	79
UNNAMED STREAM ENTERING GARDINER LAKE	
I. Bottom fauna . . . . .	89
II. Water chemistry . . . . .	89
ELLS RIVER	
I. Bottom fauna . . . . .	92
II. Water chemistry . . . . .	92
UNNAMED LAKE (99 - 16 - W4)	
I. Morphometry . . . . .	102
II. Bottom fauna . . . . .	103
III. Physical & chemical observations . . . . .	104
IV. Water chemistry . . . . .	105
V. Plankton . . . . .	106
VI. Test net results . . . . .	107
VII. Length, weight & maturity of walleye . . . . .	108
VIII. Length, weight & maturity of northern pike . . . . .	108
IX. Length, weight & maturity of lake whitefish . . . . .	109
X. Length & weight of tullibee . . . . .	109
XI. Length, weight & maturity of white suckers . . . . .	110
XII. Length, weight & maturity of perch . . . . .	110







UNNAMED LAKE (100 - 15 - W4)

I. Morphometry . . . . .	123
II. Bottom fauna . . . . .	124
III. Physical & chemical observations . . . . .	125
IV. Water chemistry . . . . .	126
V. Plankton . . . . .	127
VI. Test net results . . . . .	128
VII. Length & weight of walleye . . . . .	128
VIII. Length, weight & maturity of northern pike . . .	129
IX. Length & weight of perch . . . . .	129
X. Length & weight of tullibee . . . . .	130
XI. Length, weight & maturity of lake whitefish . . .	130







## LIST OF FIGURES

### INTRODUCTION

1. Waters of the Birch Hills area . . . . . 2

### LEGEND LAKE

1. Contour map . . . . . 15
2. Location of bottom sampling stations . . . . . 16
3. Location of net sets and water sampling  
stations. . 17
4. Composition of bottom fauna . . . . . 18
5. Growth rate of lake whitefish . . . . . 18
6. Growth rate of northern pike . . . . . 19
7. Growth rate of white suckers . . . . . 20
8. Growth rate of longnose suckers . . . . . 21

### MIKKWA RIVER

1. Location of stream stations . . . . . 28
2. Growth rate of arctic grayling . . . . . 29

### NAMUR LAKE

1. Contour map . . . . . 46
2. Location of bottom sampling stations . . . . . 47
3. Location of net sets and limnological station . . . 47
4. Composition of bottom fauna . . . . . 48
5. Limnological observations . . . . . 49
6. Growth rate of lake trout . . . . . 50
7. Growth rate of lake whitefish . . . . . 51
8. Growth rate of tullibee . . . . . 52

### NAMUR RIVER

1. Location of stream stations . . . . . 61
2. Growth rate of arctic grayling . . . . . 62

### GARDINER LAKE

1. Contour map . . . . . 80
2. Location of bottom sampling stations . . . . . 81
3. Location of net sets and limnological station . . 82
4. Composition of bottom fauna . . . . . 83







5. Growth rate of walleye . . . . .	84
6. Growth rate of northern pike . . . . .	85
7. Growth rate of lake whitefish . . . . .	86

#### ELLS RIVER

1. Location of stream stations . . . . .	93
------------------------------------------	----

#### UNNAMED LAKE (99 - 16 - W4)

1. Contour map . . . . .	111
2. Location of bottom sampling stations . . . . .	112
3. Location of net sets and limnological station . .	113
4. Composition of bottom fauna . . . . .	114
5. Growth rate of walleye . . . . .	115

#### UNNAMED LAKE (100 - 15 - W4)

1. Contour map . . . . .	131
2. Location of bottom sampling stations . . . . .	132
3. Location of net sets and limnological station . .	132
4. Composition of bottom fauna . . . . .	133
5. Limnological observations . . . . .	134
6. Growth rate of lake whitefish . . . . .	135





A PRELIMINARY BIOLOGICAL  
SURVEY OF WATERS IN THE BIRCH MOUNTAINS

INTRODUCTION

A preliminary biological survey of the major waters in the Birch Mountains was undertaken during the period from July 22 to September 9, 1967 to determine the fisheries potential of this area. The Birch Mountains are located approximately ninety air miles northwest of Fort McMurray, Alberta. During the summer this area is inaccessible except by light plane or helicopter. A light plane on floats was used to transport men and equipment into the area, and survey methods were limited accordingly.

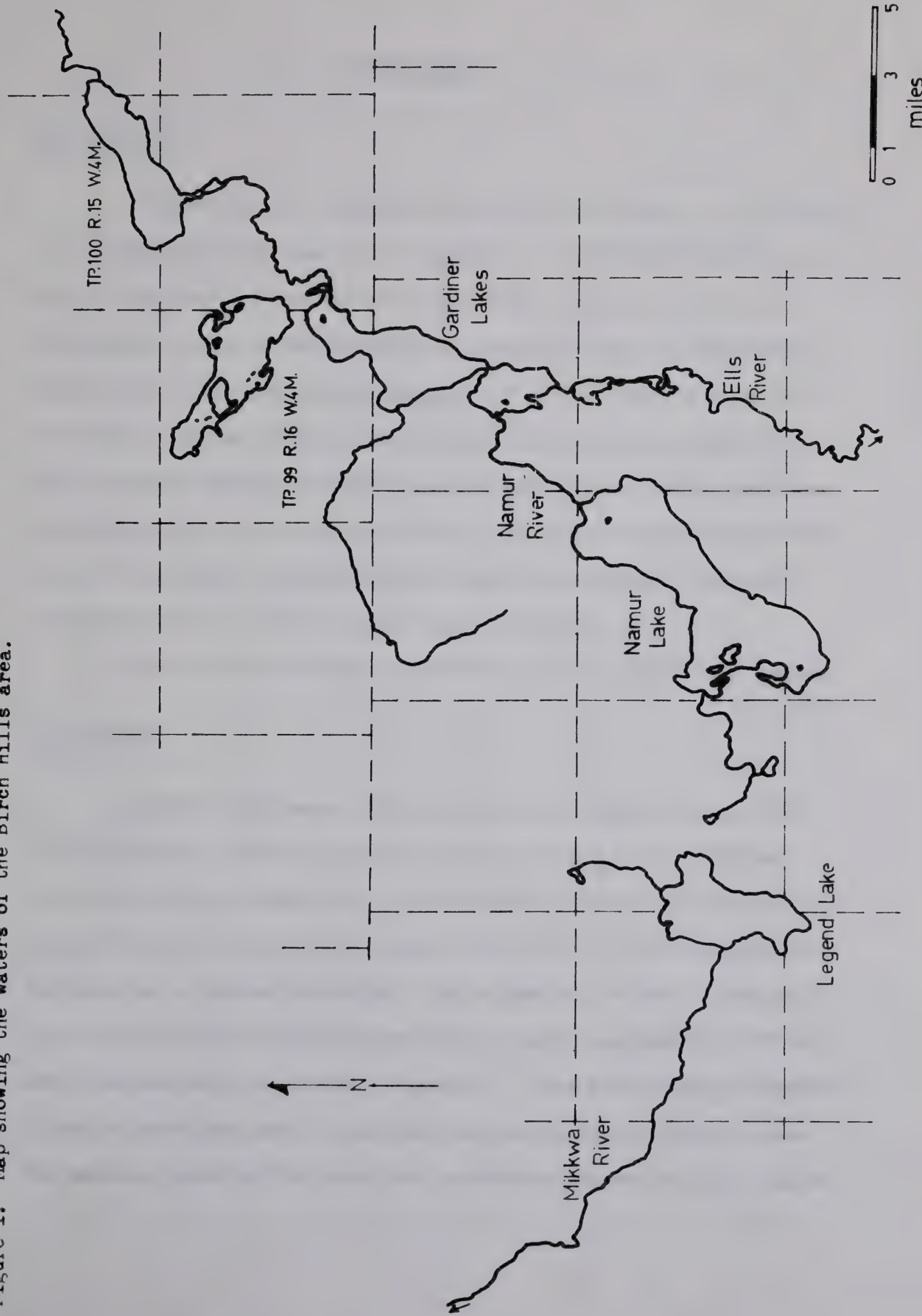
Five major lakes were examined during the survey. These included Legend Lake, Namur Lake, Gardiner Lakes, an unnamed lake in Township 99, Range 16, West of the Fourth Meridian and another unnamed lake in Township 100, Range 15, West of the Fourth Meridian (Figure 1). In addition, portions of three rivers were surveyed, the Mikkwa River, Namur River and Ells River as well as three small unnamed streams entering Legend Lake, Namur Lake and Gardiner Lakes.

The reports of these surveys are being presented in one volume since any management program must take into account all these bodies of water as a single unit.





Figure 1. Map showing the waters of the Birch Hills area.







## LEGEND LAKE

### INTRODUCTION

Legend Lake is situated in the Birch Mountains at an altitude of approximately 2590 feet and is drained by the Mikkwa River into the Peace River, part of the MacKenzie Drainage. It is located in Township 97, Range 18 and Township 97, Range 19, West of the Fourth Meridian at a latitude of approximately  $57^{\circ} 25'N$ . This is about 95 air miles northwest of Fort McMurray and is inaccessible except by float plane in summer, although the lake could be reached by dog team or tracked vehicles during the winter. Legend Lake was surveyed from July 20 to 25, 1967 to ascertain its fisheries potential. Men and equipment were flown in by a small plane on floats.

There are no records of this lake being commercially fished.

### MORPHOMETRY

Legend Lake has a surface area of 6.57 square miles (4205 acres)(Table I), a shoreline length of 14.75 miles and a shoreline development factor (comparison of the actual shoreline to the shortest length which would enclose the same area) of 1.6. This indicates that the lake has a regular shoreline. The volume of the lake is estimated to be in the order of 80,000 acre-feet; it has a mean depth of 19 feet and a maximum depth of 36 feet (Figure 1). From the depth distribution it can be seen that most of the lake waters lie in the euphotic zone. The maximum length of the lake in a north-south direction is 4.5 miles

and the maximum width is 2.3 miles, allowing the lake to be well mixed by wind action. The morphometry of this lake indicates a fair degree of eutrophy.

#### WATER CHEMISTRY

One water sample was taken during the survey period and two more were taken in September (Figure 3). All three samples were taken at the surface and are quite similar (Table III). The total alkalinity (brom-cresol green methyl-red alkalinity) was very low, being 15 parts per million. The total hardness was also very low, being from 10 to 15 parts per million calcium carbonate. Most of the hardness is due to calcium since calcium hardness measured was also 10 to 15 parts per million calcium carbonate. All samples had a pH of 6.9 which is relatively acidic for lakes in Northern Alberta. Specific conductivity (standardized to 18°C) was 29 mmhos/cm, which indicates a very low level of dissolved nutrients. The water was quite brown but there appeared to be a zooplankton 'bloom' in progress at the time of the survey. The water chemistry indicates a very low productivity for this lake.

#### BOTTOM FAUNA

Twelve bottom samples were taken, each sample consisting of four  $\frac{1}{4}$ -square foot dredgings at each location (Figure 2). The samples were washed through a screen bottom bucket (25 meshes to the inch) and the organisms preserved. These samples were analysed later in the laboratory.

From the dredgings we see that sand is found as deep as 15



feet (Table II) while organic muck is found from 12 feet down. Organic detritus was found at 17 feet and deeper, which means that decomposition of organic material proceeds at a very slow rate in this lake. Large gravel, rubble, or sand make up most of the shoreline, with rooted aquatic plants being found to depths of 15 feet.

From the samples, the standing crop of bottom fauna is estimated to be 1066 organisms per square meter, with a displaced volume of 7.75 c.c. per square meter. Chironomids were the dominant organisms, being found in every sample and making up 85 per cent of the total number of organisms. They also had the greatest displaced volume. Oligochaets made up 8 per cent of the organisms. All other organisms were insignificant in numbers and volume (Figure 4). Mayflies were very sparse in the bottom samples but some very large hatches at the beginning of the survey period were noted. It is also interesting to note the total absence of amphipods in the bottom samples. The bottom fauna indicates that Legend Lake has a low productivity.

#### FISH FAUNA

Four overnight sets of 100 yards of each of the following mesh sizes (stretch measure) were made:  $2\frac{1}{2}$ ",  $3\frac{1}{2}$ ",  $4\frac{1}{2}$ " and  $5\frac{1}{2}$ " (Figure 3). The fish caught included lake whitefish (Coregonus clupeaformis), northern pike (Esox lucius), burbot (Lota lota), tullibee (Coregonus artedii), longnose suckers (Catostomus catostomus) and white suckers (Catostomus commersoni). Most numerous in the catch were lake whitefish (Table IV). Northern pike and suckers were also numerous while tullibee and ling made up the smallest portion of the catch. No seining or poisoning was

done to obtain small fish.

#### Lake whitefish

Sixty-eight lake whitefish were examined and their lengths, weights, sex and maturity recorded. Scale samples were taken for age determination. These whitefish were quite small and slow growing, the youngest caught being seven years of age and weighing about 600 grams (Table V, Figure 5). They were maturing at seven years of age. Spawning areas for lake whitefish appeared to be quite adequate in this lake. The limiting factor for the population of lake whitefish in this lake is probably food, as the lake does not appear to be very productive and the bottom fauna is quite poor.

Thirty lake whitefish were examined for plerocercoids of Triacanthoporus crassus, 66 per cent being infested with a total of 122 cysts. The total weight of the thirty fish was 54.15 pounds, giving a rate of infestation of 224 cysts per 100 pounds of fish. This is too high for the fish to be used for human consumption and at present the only utilization possible is as animal food.

#### Northern pike

Forty-one northern pike were examined and their lengths, weights, sex and maturity recorded. Scale samples were taken for age determination. The youngest was three years and the oldest ten years of age (Table VI, Figure 6). The largest fish was 87 cm. in length and weighed 4800 grams. These fish are probably spawning at the beginning of their fifth year; spawning habitat appeared to be



adequate for the species. The dominant age class in the sample appears to be VII; this is probably not due to net selectivity. These fish are not fast growing for northern pike, which may reflect the unproductive nature of this lake.

#### Tullibee

Seventeen tullibee were examined and their lengths, weights, sex and maturity recorded. Scale samples were taken for age determination. All the fish were found to be in age class IV (Table VII). They had very little range in size, with a mean length of 233 mm. and a mean weight of 146 grams, which is quite small. The predominance of age class IV is probably due to gear selectivity, since all tullibee were caught in the 2½-inch mesh and no smaller mesh was set. The spawning habitat is probably quite adequate for this species.

#### White suckers

Twenty-six white suckers were examined and their lengths, weights, sex and maturity recorded. Scale samples were taken for age determination. These fish appeared to be fast growing (Table VIII, Figure 7). The predominant age class was III, while the oldest caught was five, but this could be due to gear selectivity. They are maturing in their third year and the lake probably has adequate spawning facilities for the species.

#### Longnosed suckers

Forty-one longnosed suckers were examined and their lengths, weights, sex and maturity recorded. Scale samples were taken for age

determination. This species is slow growing (Table IX, Figure 8). The predominant age class was VI and the oldest fish caught was VII while the youngest was III. These fish are maturing in their fifth year. The lake probably has adequate spawning habitat for this species.

#### DISCUSSION AND CONCLUSION

This lake has little potential as a sport fishery as the only sport fish present is the northern pike. The commercial fishery potential is somewhat higher but the lake whitefish are highly infested with plerocercoids of Triaenophorus crassus, which reduce their value considerably. Other commercial species, such as the suckers and tullibee, have little value and until the lake is more accessible it would not be profitable as a commercial fishery.

Using the morpho-edaphic index of Ryder (1965) we arrive at an annual production very close to three pounds per acre. This would be an annual production of all species of approximately 12,500 pounds. This could be broken down to about 4,000 pounds of whitefish, 2,000 pounds of northern pike and the remainder of tullibee, suckers and burbot. The low estimate of productivity for this lake is due to unfavourable edaphic factors, particularly its low level of dissolved nutrients.



TABLE I. Morphometry of Legend Lake.

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LOCATION: Twp. 97, Rge. 18; Twp. 97, Rge. 19, West of the Fourth M.

AREA: 6.57 square miles (4205 acres)

VOLUME: 79,800 acre feet

SHORELINE: 14.7 miles

SHORELINE DEVELOPMENT FACTOR: 1.6

MAXIMUM LENGTH: 4.5 miles

MAXIMUM EFFECTIVE LENGTH: 4.5 miles

MAXIMUM WIDTH: 2.3 miles

MAXIMUM EFFECTIVE WIDTH: 2.3 miles

MEAN WIDTH: 1.5 miles

MAXIMUM DEPTH: 36 feet

MEAN DEPTH: 19 feet

DEPTH DISTRIBUTION:

Surface area;	6.57 sq. mi. (4205 a.)	= 100% surface area
10 feet plus:	5.03 sq. mi. (3219 a.)	= 77% surface area
20 feet plus:	3.91 sq. mi. (2502 a.)	= 60% surface area
30 feet plus:	0.73 sq. mi. ( 467 a.)	= 11% surface area

---

TABLE II. Bottom fauna from Legend Lake.

Station No.	Depth (feet)	Substrate	Odonata	Ephemeroptera	Chironomidae	Oligochaeta	Gastropoda	Pelecypoda	Others	Total No.	Displaced Volume (c.c.)
67139	4	sand	-	-	119	8	-	8	-	135	0.15
67147	7	sand	-	1	42	7	1	-	-	51	0.15
67142	10	sand, gravel	-	2	120	3	-	-	4	129	0.25
67140	12	sand, muck	-	-	159	-	-	1	-	160	0.20
67144	13	sand, muck	-	-	106	3	-	3	1	113	0.25
67143	15	sand, gravel	-	-	150	2	-	-	-	152	0.20
67138	17	muck, detritus	-	-	163	13	-	3	2	191	0.85
67145	21	muck	-	-	41	10	-	16	-	67	0.90
67141	28	muck, detritus	1	-	36	15	-	18	-	70	2.00
67137	30	muck, detritus	-	-	16	12	-	5	-	33	1.00
67136	31	muck, detritus	-	-	43	18	-	-	-	61	2.20
67146	31	muck	-	1	21	5	-	3	-	30	0.55



TABLE III. Water chemistry, Legend Lake.

Sample No.	67035	67093	67094
Depth (feet)	0	0	0
Temperature (°C.)	13.5	-	-
Dissolved oxygen (ppm)	10	-	-
Phenolphthalein alkalinity (ppm CaCO <sub>3</sub> )	0	0	0
Total alkalinity (ppm CaCO <sub>3</sub> )	15	15	15
Calcium hardness (ppm CaCO <sub>3</sub> )	10	15	15
Total hardness (ppm CaCO <sub>3</sub> )	10	15	15
pH (Hellige)	6.9	6.9	6.9
Conductivity (mmhos/cm @ 18°C.)	-	29	29
Date	21-VIII-67	9-IX-67	9-IX-67

TABLE IV. Test net results, Legend Lake, July 21 - 22, 1967.

Net Set No.	Duration of set (hours)	Mesh Size (ins.)	Depth Fished (feet)	Lake whitefish	Northern pike	Burbot	Tullibee	Longnose sucker	White sucker	Total
67052	18	4½	15	36	3	4	-	26	-	69
67053	18	5½	30	8	-	6	-	1	-	15
67054	17	3½	6	42	28	-	-	5	7	82
67055	18	2½	8	2	10	-	17	9	19	57
Totals				88	41	10	17	41	26	223



TABLE V. Length, weight and maturity of lake whitefish from Legend Lake. Sixty-eight fish were examined, their ages determined from scale samples. (See Figure 5).

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{X}$	$S\bar{X}$	range	$\bar{X}$	$S\bar{X}$	range
VII+	9	5	9	366	$\pm 2.4$	355-377	609	$\pm 16.3$	540- 680
VIII+	28	16	28	383	$\pm 2.0$	354-397	695	$\pm 10.5$	580- 780
IX+	18	6	18	402	$\pm 2.0$	380-416	836	$\pm 16.3$	680- 980
X+	11	2	11	418	$\pm 3.2$	403-435	979	$\pm 36.4$	815-1260
XI+	2	1	2	457			1270		

TABLE VI. Length, weight and maturity of northern pike from Legend Lake. Forty-one fish were examined, their ages determined from scale samples. (See Figure 6).

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{X}$	$S\bar{X}$	range	$\bar{X}$	$S\bar{X}$	range
III+	1	0	1	425			520		
IV+	4	2	2	459	$\pm 18.3$	427-508	975	$\pm 275$	560-1720
V+	5	1	5	546	$\pm 6.9$	530-567	1234	$\pm 46$	1130-1360
VI+	6	2	6	586	$\pm 12.4$	546-628	1513	$\pm 119$	1010-1800
VII+	12	7	12	650	$\pm 9.2$	600-695	2164	$\pm 101$	1670-2780
VIII+	8	7	8	731	$\pm 10.8$	679-780	2712	$\pm 153$	2300-3500
IX+	3	3	3	804	$\pm 13.5$	785-830	3540	$\pm 153$	3340-3840
X+	2	2	2	870			4815		4710-4920

TABLE VII. Tullibee from Legend Lake. Seventeen fish were examined, all from 2½ inch mesh. Ages were determined from scale samples. All were mature.

Age Class	n	♀♀	Fork length (mm)			Weight (gms)		
			$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
IV+	17	8	233	±1.9	222-247	146	±3.8	120-180

TABLE VIII. Length, weight and maturity of white suckers from Legend Lake. Twenty-six fish were examined, their ages determined from scale samples. (See Figure 7).

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
II+	5	2	0	278	±6.2	264-300	274	±17.5	245- 340
III+	14	9	4	320	±5.9	279-351	460	±28.8	280- 620
IV+	5	2	5	377	±7.8	367-406	776	±25.1	695- 845
V+	2	1	2	440		431-449	1150		1000-1300

TABLE IX. Length, weight and maturity of longnose suckers from Legend Lake. Forty-one fish were examined, their ages determined from scale samples. (See Figure 8).

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
III+	1	0	0	210			259		
IV+	3	1	1	308	± 5.8	300-319	395	±25.7	360- 445
V+	6	5	5	383	±11.7	348-414	703	±53.1	500- 860
VI+	27	22	25	428	± 3.1	383-456	1004	±23.4	770-1240
VII+	4	4	4	459	± 3.7	451-467	1180	±74.8	1020-1380



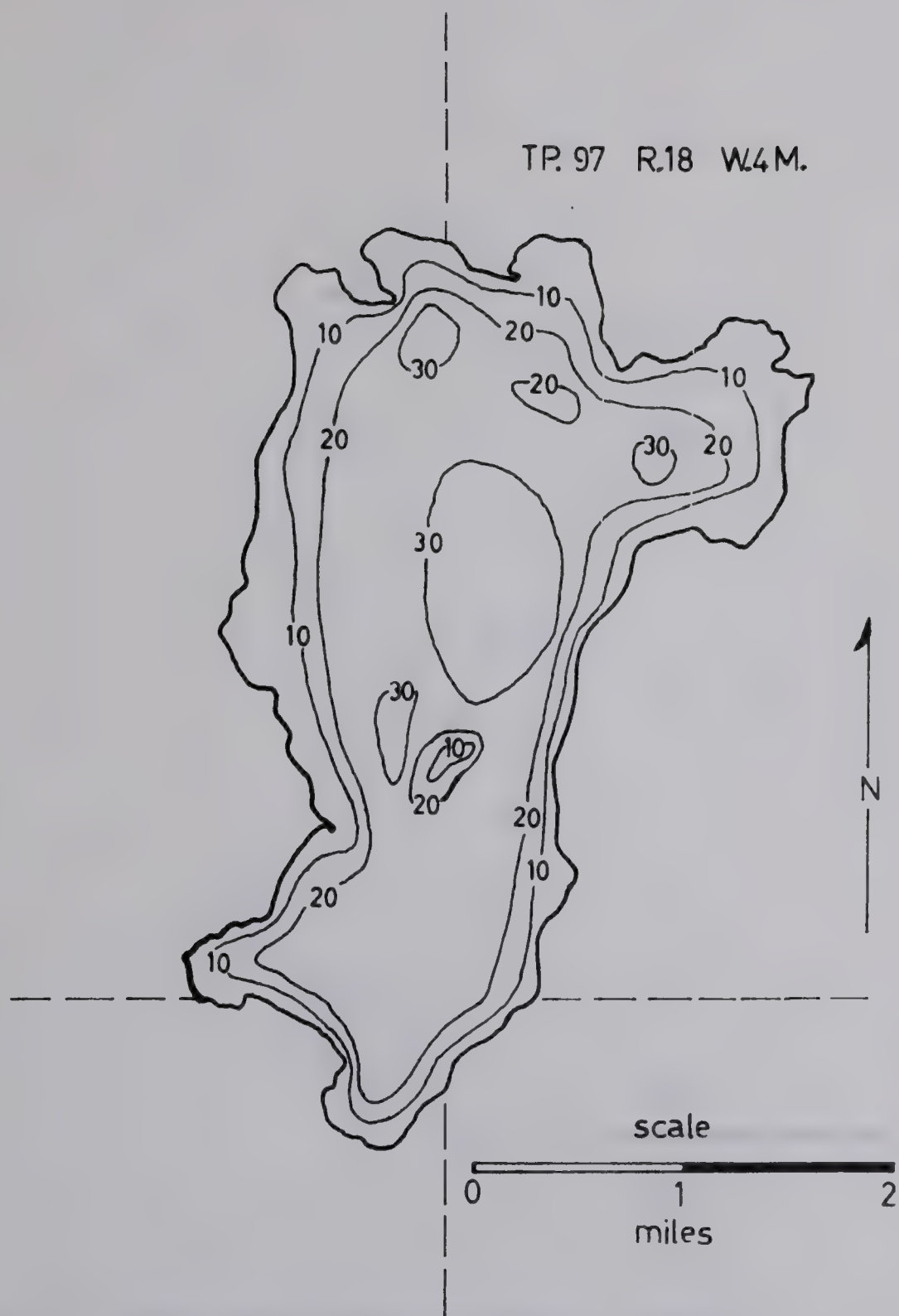


Figure1. Legend Lake contour map. Contour intervals of 10 feet.







Figure 2. Legend Lake bottom sampling stations,  
eg. • 67143





Figure 3. Legend Lake net sets (xxx67055) and water sampling stations (•67093)





Figure 4. Composition of bottom fauna from Legend Lake.

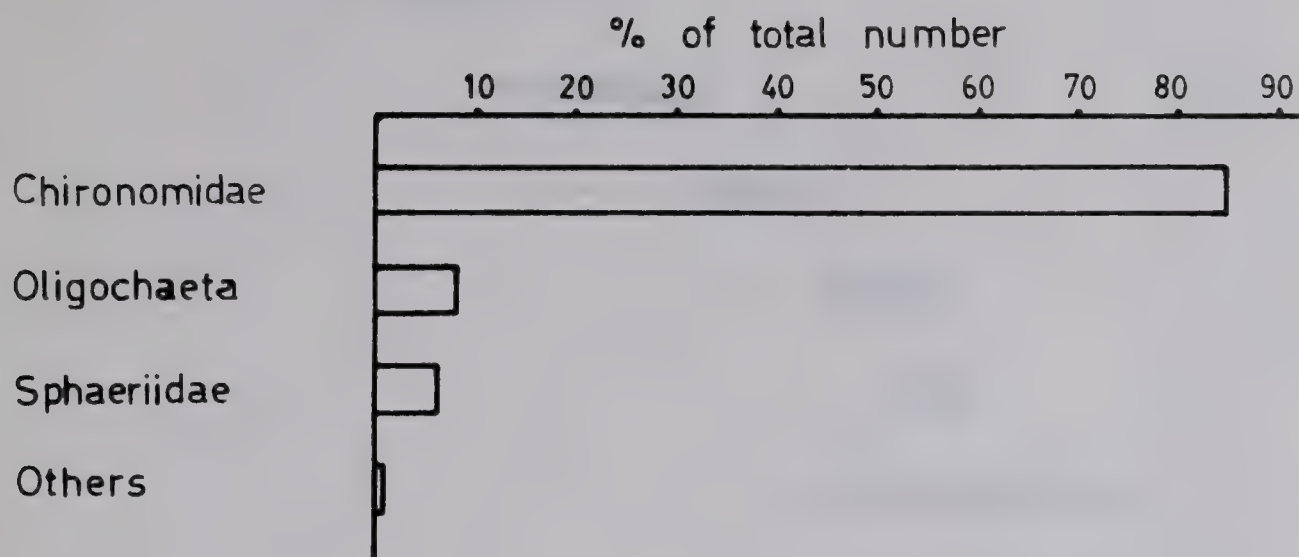


Figure 5. Growth of lake whitefish from Legend Lake, July 1967. The figure shows the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.

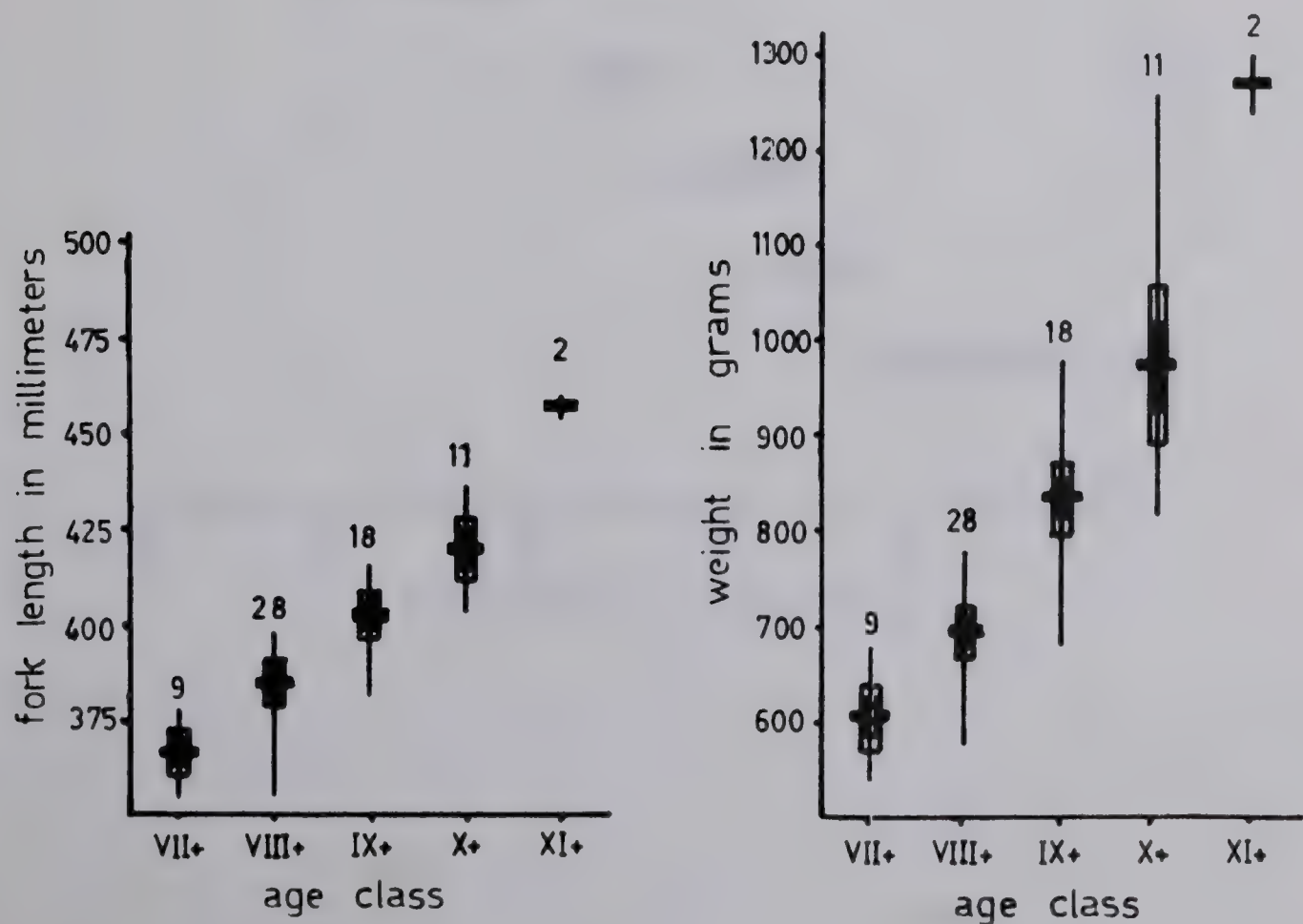






Figure 6. Northern pike from Legend Lake, July 1967. The figure shows the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.

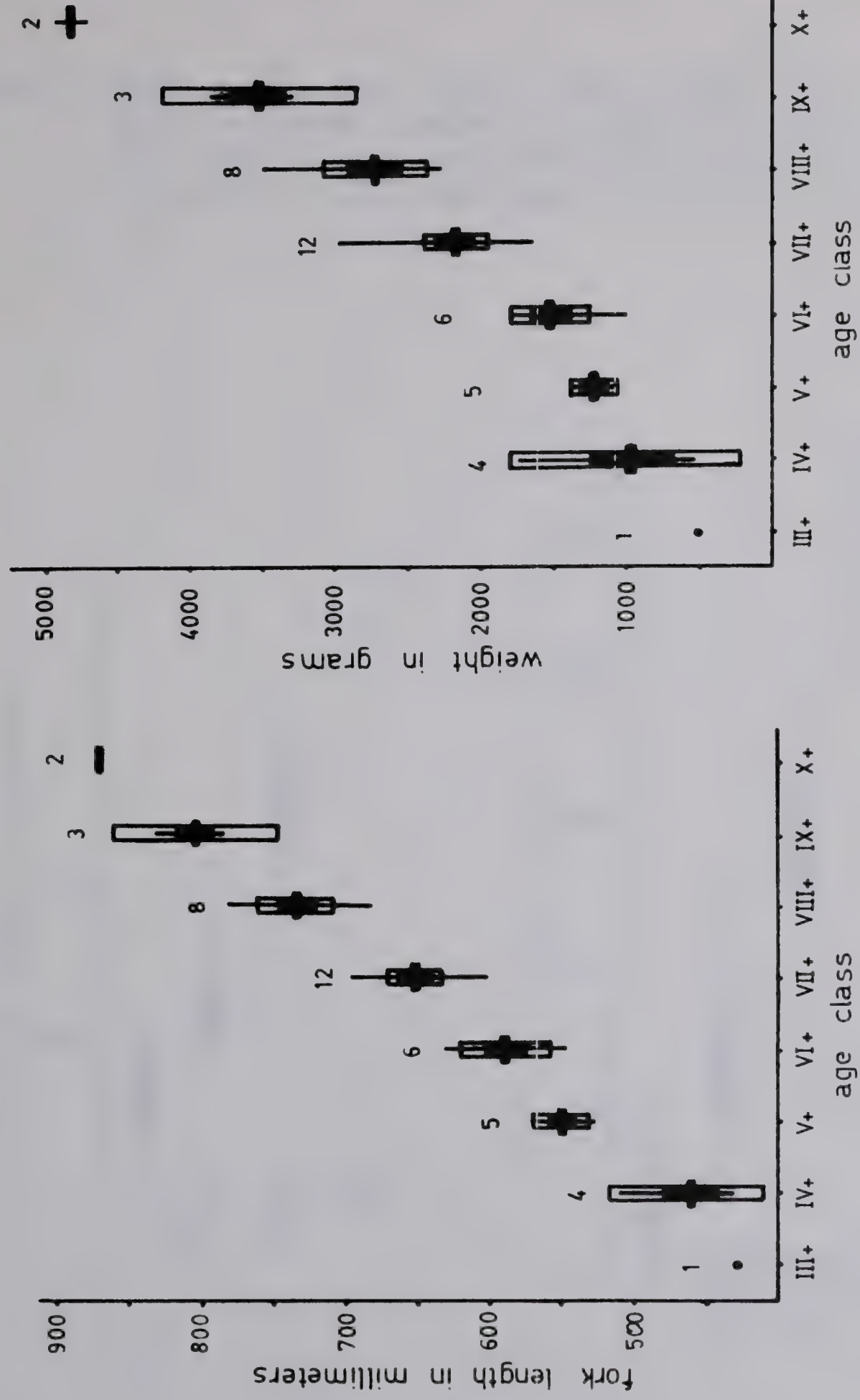




Figure 7. White suckers from Legend Lake, July 1967. The figure shows the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.

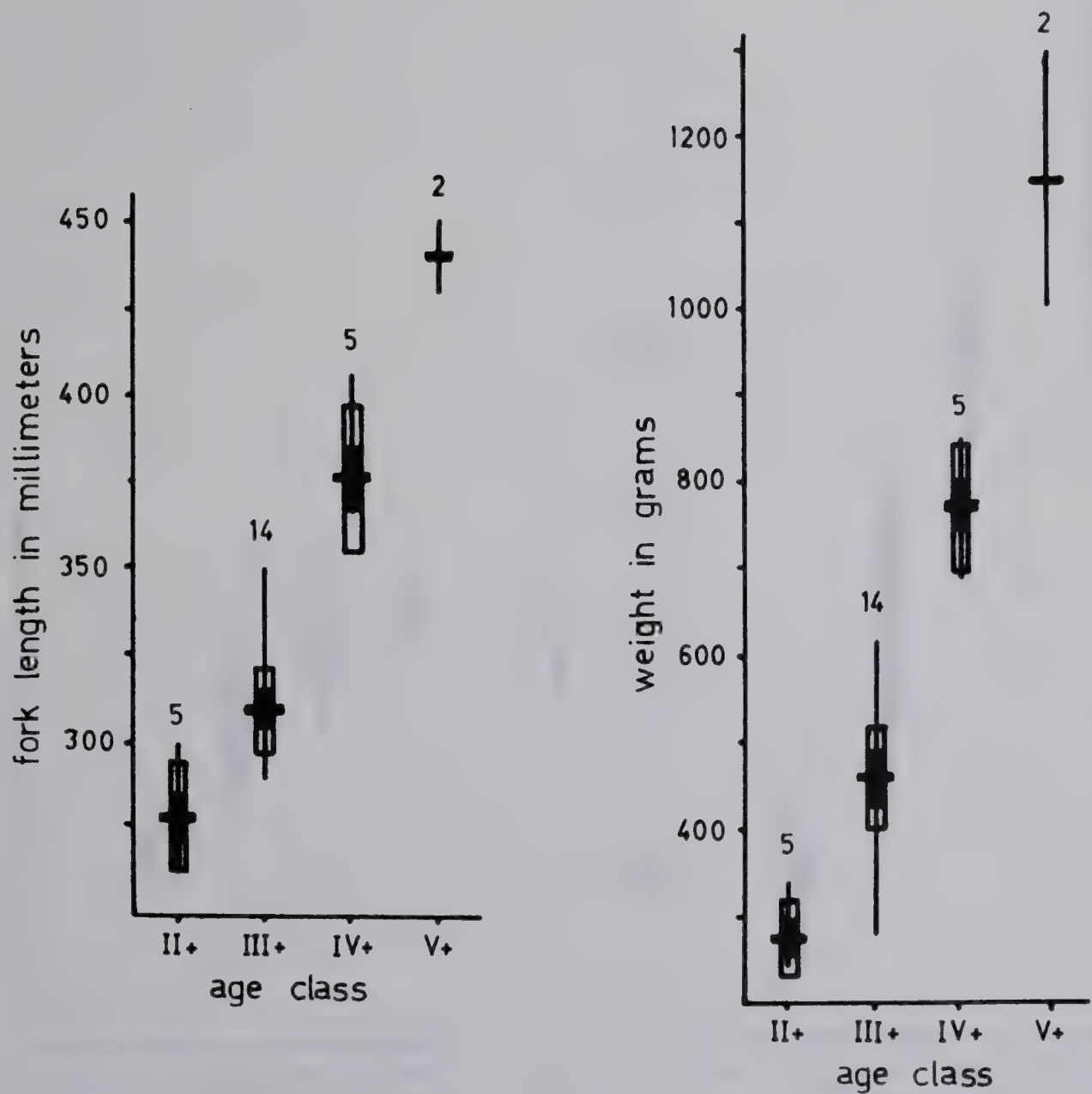
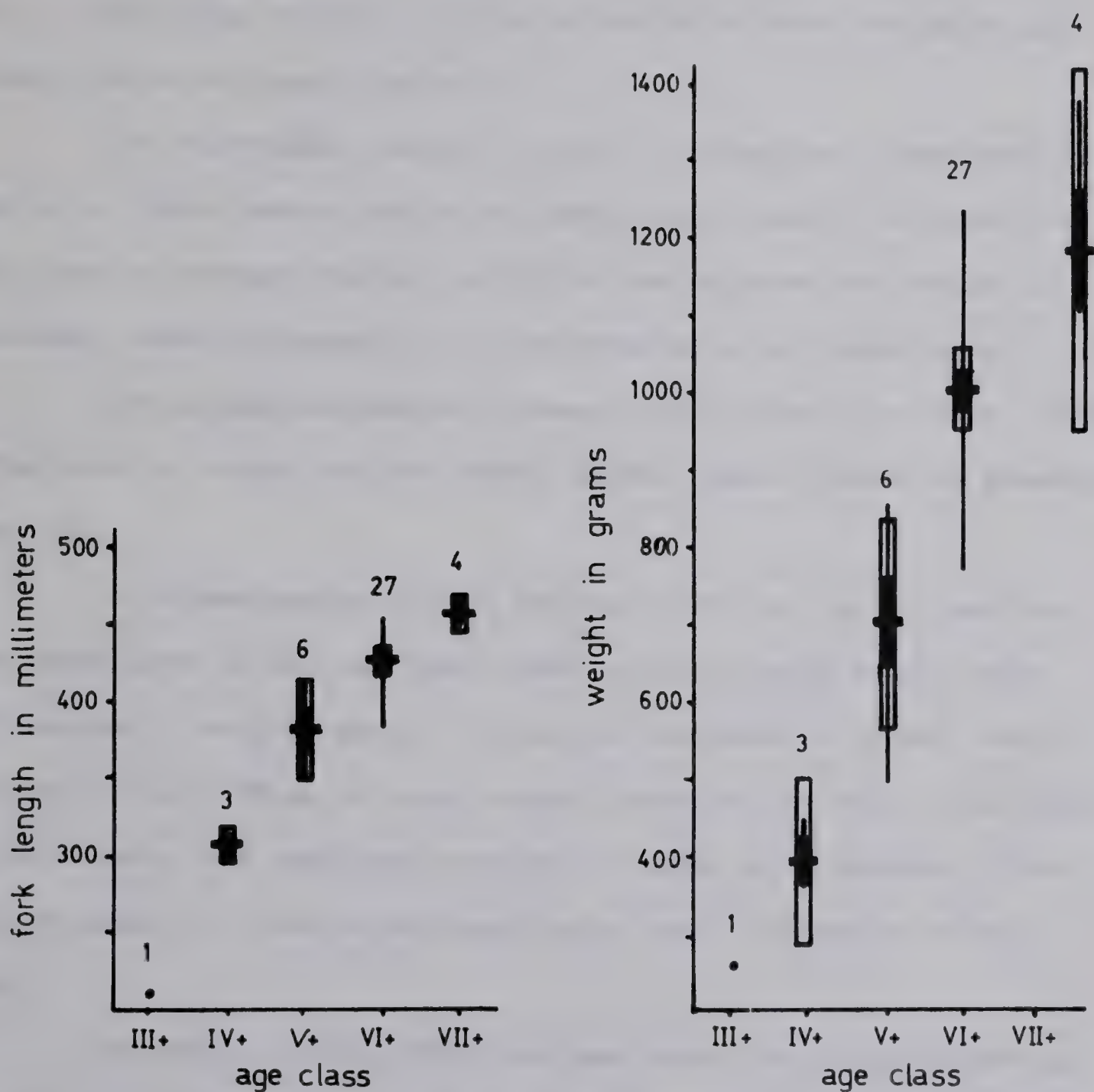






Figure 8. Longnose suckers from Legend Lake, July 1967. The figure shows the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.







### MIKKWA RIVER

The Mikkwa River has Legend Lake as its point of origin, the location being in Township 97, Range 19, West of the Fourth Meridian. The river drains west northwest into the Peace River, thus forming part of the MacKenzie Drainage. The stream was examined on July 23 and July 25, 1967 from its point of origin to a point about six miles downstream from Legend Lake (Figure 1).

The surrounding country is gently rolling, with some deciduous tree cover, white spruce, and muskeg with black spruce. The upper ten miles have an average gradient of 30 feet per mile and the stream has a moderate velocity, except for a few large pools and beaver dams.

Two stream stations were taken on this river, the first (#67004) at the point of origin and the second (#67005) about five miles downstream from this.

At stream station #67004 the mean width was 14 feet and the mean depth about 12 inches. There were two large pools in 150 yards and many small, shallow pools. The bottom consisted of gravel, rubble and sand in the riffles and muck, organic detritus and sand in the pools. The shore cover was excellent, none of the banks being exposed. There did not appear to be any significant water level fluctuation at this point.

At stream station #67005 the mean width was about 18 feet but the mean depth was 9 inches. Pools here were small and infrequent, although there was good bank cover. Most of the bottom consisted of small rubble and gravel. At this location (and for about three of the

six miles examined) the channel was braided and the stream velocity quite rapid.

Bottom samples were taken at each station with a square foot surber sampler. The three samples taken at station #67004 were quite rich and contained primarily black-fly larvae (Simulium sp.) and caddisfly larvae (Trichoptera). The richness of this portion of the stream is probably a result of the plankton content originating in Legend Lake. The three samples taken downstream (Station #67005) were quite poor, although a greater variety of organisms was present (Table I).

Water samples were taken at each station and analyzed (Table II). The total alkalinity was very low, as was the hardness of the water. The pH changed from 7.1 at the origin of the stream to 6.5 at the second station. The conductivity was very low (26-27 mmhos/cm @ 18°C) and the temperature ranged from 17 to 18°C.

The stream was treated with rotenone at its origin to determine what species of fish were present and their relative abundance. Arctic grayling (Thymallus arcticus) were by far the most abundant species, although many young-of-the-year northern pike (Esox lucius) were also found. Burbot (Lota lota), longnose suckers (Catostomus catostomus) and white suckers (Catostomus commersoni) were also collected.

Sixty arctic grayling were examined and the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination. These fish are quick maturing and appear to spawn at the beginning of their third year of life. However, they do not get very large, the largest obtained weighing 380 grams (Table III, Figure 2), but they still provide excellent sport fishing.



On July 25, 1967 a small stream entering Legend Lake (part of the Mikkwa River System) was examined where it entered the Lake (stream station #67006). The mean width was about 12 feet while the mean depth was two feet. The stream was generally slow flowing, and the bottom consisted of rubble, gravel, sand and muck. Shore cover was quite good, none of the bank being exposed at the station. The water was quite cold ( $10^{\circ}\text{C}$ ) and was very brown (secchi disc of 2 feet). Treatment with rotenone failed to produce any fish. Two water samples were taken (Table III) and analyzed. The water had very little alkalinity or hardness, a very low pH and a low conductivity. This small stream has very little or no value as a fishery.



TABLE I. Bottom organisms from surber samples taken at stream stations 67004 and 67005 on July 23 and 25, 1967. Only the presence (x) or absence (-) of an organism in a sample is noted. Samples 67148 to 67150 were taken at station 67004 and samples 67151 to 67153 were taken at station 67005.

Group	Organism	Sample No.					
		67148	67149	67150	67151	67152	67153
Nematoda		x	x	x	-	x	-
Oligochaeta	Lumbriculidae	-	-	-	x	-	-
Hirudinea	<u>Helobdella stagnalis</u>	x	-	x	-	-	-
Plecoptera	<u>Nemoura sp.</u>	-	-	-	x	-	-
	<u>Isogenus sp.</u>	-	-	-	-	x	x
	<u>Pteronarcella sp.</u>	-	-	-	-	-	x
Ephemeroptera	<u>Ephemerella sp.</u>	-	-	-	x	-	x
	<u>Baetis sp.</u>	-	x	x	x	-	-
	<u>Heptagenia sp.</u>	-	-	-	x	-	-
Trichoptera	<u>Neuraclipsis sp.</u>	x	x	x	x	x	x
	<u>Hydropsyche sp.</u>	-	-	-	x	x	-
	<u>Brachycentrus sp.</u>	-	x	x	-	x	-
	<u>Glossosoma sp.</u>	-	-	x	-	-	-
	<u>Platycentropus sp.</u>	-	-	x	-	-	-
Hemiptera	<u>Hydrometra sp.</u>	x	-	-	-	-	-
Coleoptera	<u>Hydrotrupes sp.</u>	-	-	x	-	-	-
Diptera	<u>Simulium sp.</u>	x	x	x	-	x	x
	Culicidae	x	x	x	x	-	-
	Chironomidae	x	x	x	-	-	-
	<u>Atherix sp.</u>	-	-	-	x	x	-

TABLE II. Water chemistry, Mikkwa River. Samples 67037 and 67038 were taken at station 67004 while the other two were taken at station 67005.

Sample No.	67037	67038	67041	67042
Temperature ( $^{\circ}\text{C}$ )	17	18	17	17
Dissolved Oxygen (ppm)	10	9	8	8
Total alkalinity (ppm $\text{CaCO}_3$ )	15	20	15	15
Ca hardness (ppm $\text{CaCO}_3$ )	10	10	5	5
Total hardness (ppm $\text{CaCO}_3$ )	15	10	10	10
pH (Hellige)	7.1	7.1	6.5	6.5
Conductivity (mmhos/cm @ $18^{\circ}\text{C}$ )	-	-	27	26

TABLE III. Lengths and weights of arctic grayling from the Mikkwa River. July 23, 1967.

Age Class	n	Fork Length (mm)			$\bar{x}$	Weight (gms)	
		$\bar{x}$	$S\bar{x}$	range		$S\bar{x}$	range
I+	15	139	$\pm 3.1$	132-146	39	$\pm 2.7$	33- 45
II+	32	222	$\pm 3.2$	216-228	152	$\pm 6.2$	139-165
III+	8	274	$\pm 4.7$	263-285	251	$\pm 12.7$	221-281
IV+	5	300	$\pm 1.7$	295-305	342	$\pm 12.8$	306-378

TABLE IV. Water chemistry - Unnamed stream entering Legend Lake. July 25, 1967.

Sample No.	67039	67040
Total alkalinity (ppm $\text{CaCO}_3$ )	10	5
Ca Hardness (ppm $\text{CaCO}_3$ )	5	5
Total Hardness (ppm $\text{CaCO}_3$ )	15	15
pH (Hellige)	6	6
Conductivity (mmhos/cm @ 18°C)	25	25



Figure 1. Locations of stream stations on the Mikkwa River and a small stream entering Legend Lake.





Figure 1. Locations of stream stations on the Mikawa River and a small stream entering Legend Lake.







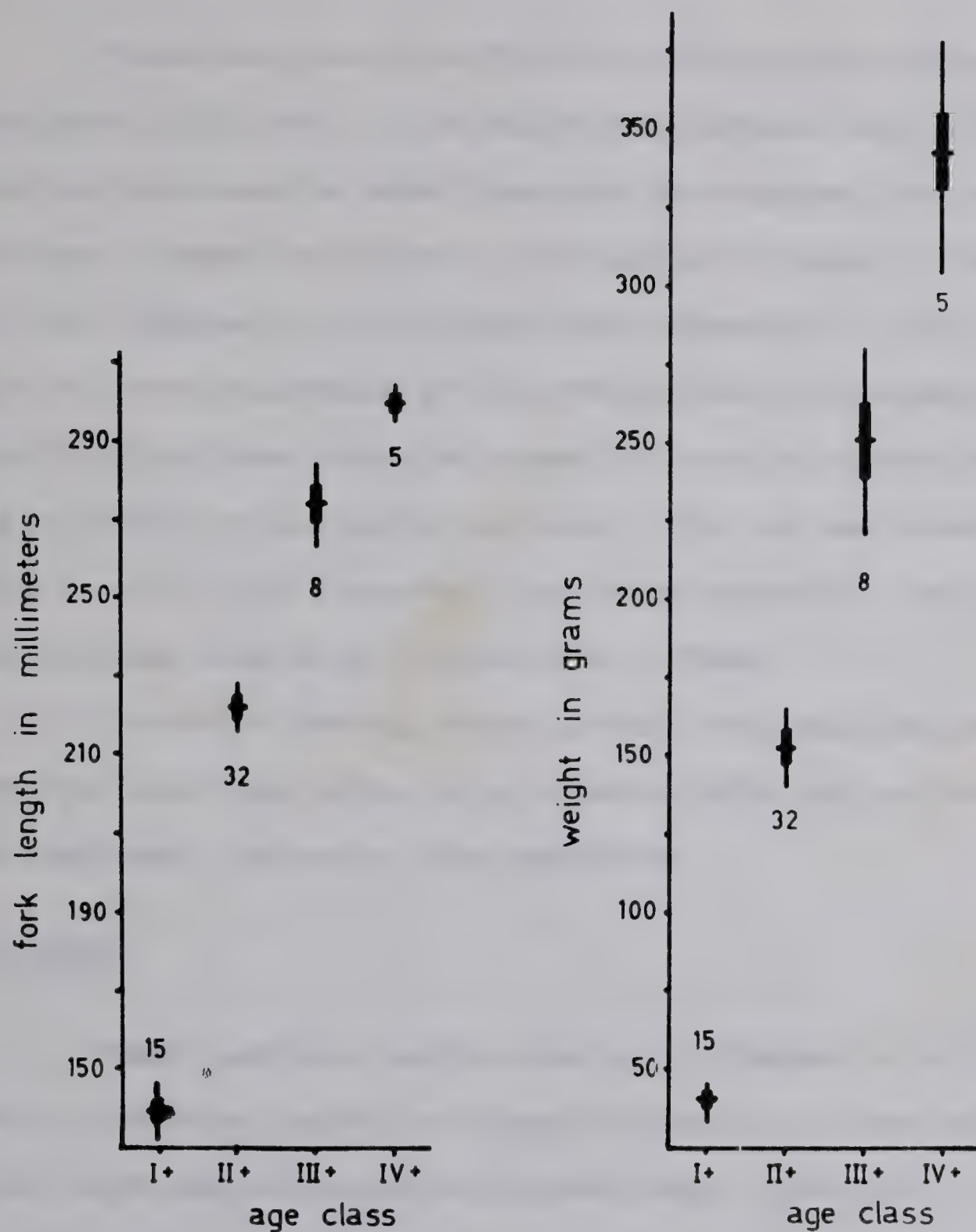


Figure 2. Arctic grayling from the Mikkwa River, July 1967. The figures show the mean, standard error and range in fork length and weight for each age class. The number in each age class is indicated.





## NAMUR LAKE

### INTRODUCTION

Namur Lake lies in the Birch Mountains at an altitude of approximately 2375 feet. It is drained into Gardiner Lakes by the Namur River and from there the water flows into the Athabasca River via the Ells River. Namur Lake is located in Township 97, Range 17, West of the Fourth Meridian, at a latitude of approximately  $57^{\circ} 25' \text{N}$ . This is about 90 air miles northwest of Fort McMurray and is inaccessible except by float plane during the summer but could be reached by dog team or tracked vehicle during the winter. The lake was surveyed from August 6 to 18, 1967 to ascertain its fishery potential. Men and equipment were flown in by a light plane on floats.

Commercial fishing records indicate that this lake has been fished for lake trout in the past. A few whitefish and northern pike have been taken, but not in large quantities.

### MORPHOMETRY

Namur Lake has a surface area of 16.87 square miles (10,797 acres), a shoreline length (including the shoreline of four islands) of 31.0 miles and a shoreline development factor (comparison of the actual shoreline to the shortest length which would enclose the same area) of 2.1. This means that the shoreline is moderately irregular.

The volume is estimated to be in the order of 469,000 acre feet; the mean depth is 43 feet while the maximum depth found was 92



feet (Figure 1). From the depth distribution it can be seen that about three quarters of the lake is deeper than thirty feet while about one half is deeper than 50 feet. The shoal area is relatively small.

The maximum length of the lake, in a northeast-southwest direction, is 8.5 miles, while the maximum effective length (the longest stretch of open water with no obstructions to wind action) is 8.3 miles and the maximum width of the lake is 3.4 miles. There is good wind action on the lake, which should keep the epilimnion well mixed.

The morphometry of this lake indicates a fair degree of oligotrophy (Table I).

#### PHYSICAL AND CHEMICAL FEATURES

A limnology station was taken August 14, 1967 (Figures 3 and 5, Table III). A thermocline was found between 35 and 40 feet and below this the temperature was less than 12°C, which is within the preferred temperature range for lake trout.

The dissolved oxygen ranged from 8 to 10 ppm and there was no oxygen depletion at the bottom. The lowest amount of dissolved oxygen was found at 45 feet, just below the thermocline, with 72 per cent saturation, while the highest value was found at 20 feet with 100 per cent saturation. The high dissolved oxygen values in the epilimnion are probably due to the strong mixing action of the wind on this lake and the production of molecular oxygen by phytoplankton.

The pH was close to neutrality, being 7.1 above the thermocline, 7.0 at the thermocline, 6.9 and 6.8 at 45 feet and 60 feet respectively, but back to 7.1 at 80 feet. There is probably very little decomposition occurring on the bottom of this lake. The water was clear, with a



secchi disc visibility of 17 feet.

Water chemistry in the main lake shows the water to be low in total alkalinity (20 to 30 ppm calcium carbonate) and quite soft, with a calcium hardness of 20 ppm calcium carbonate and a total hardness of 20 to 25 ppm calcium carbonate. The conductivity, standardized to 18°C, varied from 40 to 45 mmhos/cm which indicates a low level of dissolved nutrients in the water (Table IV).

One sample taken at an inflowing spring showed this water to have a low conductivity, no measurable alkalinity (pH must be below 4.5), little calcium hardness and a high total hardness.

The limnology and water chemistry on this lake indicate an oligotrophic nature.

#### BOTTOM FAUNA

Twenty-five bottom samples were taken, each sample consisting of four  $\frac{1}{4}$ -square foot dredgings at each location (Figure 2). The samples were washed through a screen bottomed bucket (25 mesh per inch) and all living organisms preserved. These samples were analyzed later in the laboratory (Table II).

From the bottom samples it can be seen that sand predominates down to fifteen feet and is found as deep as 32 feet. Organic muck was found as shallow as 15 feet and all samples below 45 feet were of this material. There were many areas of gravel and rubble noted but these could not be sampled. Most of the shoreline was of sand, gravel or rubble with very little aquatic vegetation present in the lake.

From these samples, the standing crop of bottom fauna was

estimated to be 915 organisms per square meter with a displaced volume of 3.40 c.c. per square meter. Chironomids were the dominant organisms found in all samples and made up 86.4 per cent of the total number of organisms. Pelecypods (all sphaeriids) made up 7.2 per cent of the organisms and oligochaetes made up 3.9 per cent of the organisms, while all others were insignificant in number and volume (Figure 4). It should be noted that all amphipods found belonged to the genera Gammarus and Hyallela and that no Pontoporeia were found.

The bottom fauna indicates a low productivity for this lake.

#### PLANKTON

Plankton samples were taken at the limnology station on August 16, 1967. Four vertical hauls (one each from 40 and 35 feet and two from 30 feet) were made with a Wisconsin-type plankton net having a mouth diameter of 20 cm. The plankton samples were preserved and examined later. The settled volumes were determined for each haul and ranged from 4.0 to 5.6 c.c. About one half of the net plankton was zooplankton.

A large portion of the phytoplankton consisted of blue-green algae, typical of fall plankton blooms (Table V). The blue-green algae were dominated by Oscillatoria, but also present were Gomphosphaeria, Anacystis and Anabaena. There were also a fair number of diatoms, particularly Asterionella and Tabellaria. The dinoflagellates were present in good numbers, being represented by the genus Ceratium, while the green algae were scarce, only Staurostrum being found in the samples.



The zooplankton was made up of two species of rotifers, cladocera (probably Daphnia) and copepods (probably Cyclops).

The plankton is actually quite sparse and may be indicative of the oligotrophic nature of this lake.

#### FISH FAUNA

Overnight gill net sets were made using each of the following mesh sizes (stretch measure):  $1\frac{1}{2}$ ,  $2\frac{1}{2}$ ,  $3\frac{1}{2}$ ,  $4\frac{1}{2}$  and  $5\frac{1}{2}$  inches. All were 100 yards in length except the  $1\frac{1}{2}$  inch mesh which was 50 yards in length (Table VI, Figure 3).

Fish caught in the nets included lake trout (Salvelinus namaycush), lake whitefish (Coregonus clupeaformis) and tullibee (Coregonus artedii). The lake trout were caught in all mesh sizes when the nets were set below sixty feet. The lake whitefish were caught mostly in the  $3\frac{1}{2}$ -inch mesh while the tullibee were caught mostly in the  $1\frac{1}{2}$ -inch mesh and would appear to be the most numerous species in the lake. No northern pike were caught in the nets but the nets were not set in locations where pike would be expected. Northern pike are probably not very numerous in this lake as the amount of suitable habitat for them is limited.

Use of rotenone along the shore yielded young-of-the-year arctic grayling (Thymallus arcticus).

#### Lake trout

Forty-two lake trout were caught in gill nets. Their fork lengths, weights, sex and maturity were recorded. Stomach contents were examined and recorded and scale samples were taken for age



determination.

These fish ranged in age from three to thirteen years (Table VI, Figure 6) while they ranged in length from 297 to 883 mm and in weight from 290 to 9500 grams. The most abundant age classes in the sample were VII, VIII and IX. These lake trout appear to be relatively fast growing.

Most males are mature in their seventh year but most of the females will not spawn until their eighth year. The lake appeared to be adequately supplied with suitable lake trout spawning areas.

From the stomach analysis it can be seen that most of these fish are feeding on tullibee or small whitefish, of which there are large numbers in this lake. This may partially account for their relatively fast growth rate.

Lake trout habitat did not appear to be significantly reduced in summer as a result of thermal stratification.

### Lake whitefish

Sixty lake whitefish were examined and their fork lengths, weights, sex and maturity recorded. Scale samples were taken for age determination.

These whitefish were caught mostly in the 3½-inch mesh net. They are small and very slow growing (Table VIII, Figure 7). At nine years of age they are 384 mm in length and weigh 647 grams and the predominant age class in the sample was VIII.

Most of these fish are mature at seven years of age and spawn during that year. Spawning habitat for lake whitefish in this lake is

more than adequate.

Many of the lake whitefish appeared to be "bleeding" when taken from the water. Small blood spots about the sizes of dimes and quarters appeared over the body, but particularly in the caudal region and around the pectoral fins. This may have been due to super-saturation (A. C. Sinclair, personal communication). These whitefish are of poor market quality.

Thirty lake whitefish were examined for plerocercoids of Trienophorus crassus. Eighteen (60 per cent) were infested with a total of 64 cysts. The weight of these fish was 30.31 pounds, giving a rate of infestation of approximately 211 cysts per 100 pounds of fish. These fish are unsuitable for the commercial market.

### Tullibee

Forty-three tullibee were examined and their fork lengths, weights, sex and maturity recorded. Scale samples were taken for age determination.

Most of the tullibee were caught in the 1½-inch mesh nets. They are very small and quite slow growing (Table IX, Figure 8). The youngest caught was two and the oldest was six years of age. Fish in their fourth year averaged 264 mm in length and 175 grams in weight.

Most of these fish will spawn in their second year. Spawning habitat for tullibee in this lake appears to be more than adequate.

The tullibee are probably the most numerous fish in this lake and probably have by far the greatest biomass. They provide excellent forage for lake trout and for this reason are valuable to the sport fishery.

## DISCUSSION AND CONCLUSIONS

Using the morpho-edaphic index of Ryder (1965) an estimate of total annual fish production of close to two pounds per acre is obtained, or approximately 22,000 pounds. However, this is probably somewhat low and the total annual production is perhaps better estimated at close to 25,000 pounds.

About one fifth of this yield is probably in the form of piscivorous fish, such as lake trout, which is the only species at this trophic level of any significance in Namur Lake. This would provide an estimated sustained yield of approximately 5,000 pounds of lake trout per year.

The remainder of the production of fish would be in the form of tullibee and lake whitefish (about 20,000 pounds). The tullibee are very small and the whitefish are heavily infested with plerocercoids of Trienophorus crassus, so that neither species has much commercial value.

This lake should definitely be reserved as a sport fishery. A commercial fishery on this lake would greatly detract from its value as a sport fishery, since the lake trout population would be quickly depleted.



TABLE I. Morphometry of Namur Lake.

LOCATION:	Tp. 97 - R. 17 - W4th Meridian				
AREA:	16.87 mi. <sup>2</sup> (10,797 acres)				
VOLUME:	469,000 acre feet				
SHORELINE:	31.0 miles				
SHORELINE DEVELOPMENT FACTOR:	2.1				
MAXIMUM LENGTH:	8.5 miles				
MAXIMUM EFFECTIVE LENGTH:	8.3 miles				
MAXIMUM WIDTH:	3.4 miles				
MAXIMUM EFFECTIVE WIDTH:	3.4 miles				
MEAN WIDTH:	2.0 miles				
MAXIMUM DEPTH:	92 feet				
MEAN DEPTH:	43 feet				
DEPTH DISTRIBUTION:					
Surface Area	16.87 mi. <sup>2</sup>	(10,797 a)	=	100%	surface area
10 feet +	14.58 mi. <sup>2</sup>	( 9,331 a)	=	86%	surface area
20 feet +	12.44 mi. <sup>2</sup>	( 7,962 a)	=	74%	surface area
30 feet +	10.58 mi. <sup>2</sup>	( 6,771 a)	=	63%	surface area
40 feet +	8.84 mi. <sup>2</sup>	( 5,658 a)	=	52%	surface area
50 feet +	7.08 mi. <sup>2</sup>	( 4,531 a)	=	42%	surface area
60 feet +	5.41 mi. <sup>2</sup>	( 3,462 a)	=	32%	surface area
70 feet +	3.75 mi. <sup>2</sup>	( 2,400 a)	=	22%	surface area
80 feet +	2.54 mi. <sup>2</sup>	( 1,626 a)	=	15%	surface area
90 feet +	0.11 mi. <sup>2</sup>	( 70 a)	=	1%	surface area

TABLE II. Bottom fauna from Namur Lake.

Station Number	Depth (feet)	Substrate	Ephemeroptera	Trichoptera	Chironomidae	Oligochaeta	Amphipoda	Pelecypoda	Gastropoda	Others	Total	Displaced Volume (c.c.)
67172	2	sand/ gravel	2	2	15	13	11	12	2	3	60	0.25
67165	3	sand	1	3	90	5	9	1	8	1	118	0.30
67155	12	sand	-	3	82	-	-	-	-	-	85	0.10
67159	15	sand	-	1	91	-	-	1	-	-	93	0.15
67164	15	muck	-	1	36	-	-	40	-	-	77	0.20
67163	22	sand	-	-	62	3	-	10	-	1	76	0.30
67174	25	muck	-	-	56	-	-	4	-	-	60	0.15
67158	26	muck	-	-	95	5	-	-	-	-	100	0.30
67176	32	sand	-	-	25	-	-	-	-	3	28	0.05
67169	35	muck	-	-	74	-	-	4	-	-	78	0.20
67156	40	silt/clay	-	-	94	-	-	5	-	-	99	0.40
67154	44	silt/clay	-	-	120	-	-	5	-	-	125	0.40
67175	45	muck	-	-	111	-	-	11	-	-	122	0.25
67157	46	muck	-	-	133	3	-	4	-	-	140	0.35
67178	46	muck	-	-	84	-	-	10	-	-	94	0.25
67180	46	muck	-	-	48	-	-	2	-	1	51	0.15
67162	52	muck	-	-	51	30	-	5	-	-	86	0.35
67161	54	muck	-	-	75	3	-	4	-	-	82	0.30
67177	62	muck	-	-	91	1	-	10	-	-	102	0.35
67179	63	muck	-	-	89	-	-	6	-	-	95	0.30
67160	70	muck	-	-	31	4	-	4	1	-	40	0.25
67167	70	muck	-	-	44	13	-	3	-	-	60	0.25
67166	81	muck	-	-	43	-	-	-	-	-	43	0.55
67168	81	muck	-	-	98	2	-	2	-	-	102	1.10
67173	82	muck	-	-	90	-	-	9	-	-	99	1.20

TABLE III. Limnological observations on Namur Lake, August 16, 1967.

Depth (feet)	Temperature (°C)	Dissolved Oxygen		Conductivity (mmhos/cm.)	pH
		ppm	% Saturation		
0	16	9	90%	43	7.1
5	16				
10	16				
15	16				
20	16	10	100%	43	7.1
25	16				
30	16				
35	15.5	9	88%	40	7.0
37	13.5				
40	12.0				
42	12.0				
45	11.5	8	72%	43	6.9
50	10				
60	9	9	75%	42	6.8
70	8				
80	7	10	80%	45	7.1
84	7				



TABLE IV. Water chemistry, Namur Lake. Samples 67049 to 67054 were taken at the limnology station. Sample 67044 was taken at an inflowing spring on August 10, 1967.

Sample Number	67049	67050	67051	67052	67053	67054	67044
Depth (feet)	0	20	35	45	60	80	0
Temperature (°C)	16	16	15.5	11.5	9	7	7
Dissolved oxygen (ppm)	9	10	9	8	9	10	8
Phenolphthalein alkalinity (ppm $\text{CaCO}_3$ )	0	0	0	0	0	0	0
Total alkalinity (ppm $\text{CaCO}_3$ )	20	30	30	30	30	30	0
Calcium hardness (ppm $\text{CaCO}_3$ )	20	20	20	20	20	20	5
Total hardness (ppm $\text{CaCO}_3$ )	25	25	25	25	20	25	470
pH	7.1	7.1	7.0	6.9	6.8	7.1	6
Conductivity (mmhos/cm. at 18°C)	43	43	40	43	42	45	48

TABLE V. Plankton from Namur Lake. August 16, 1967.

<u>PHYTOPLANKTON</u>		
<u>GROUP</u>	<u>ORGANISM</u>	<u>RELATIVE ABUNDANCE</u>
Cyanophyta	<u>Oscillatoria</u>	Very abundant
	<u>Anabaena</u>	Abundant
	<u>Gomphosphaeria</u>	Scarce
	<u>Anacystis</u>	Scarce
Chlorophyta	<u>Staurostrum</u>	Rare
Chrysophyta	<u>Asterionella</u>	Abundant
	<u>Tabellaria</u>	Common
Pyrophyta	<u>Ceratium</u>	Abundant
<u>ZOOPLANKTON</u>		
<u>GROUP</u>		<u>RELATIVE ABUNDANCE</u>
Rotifers		Abundant
Cladocera		Abundant
*Copepoda		Very abundant

\* Copepods consisted of both adults and nauplii in the samples and were found in an approximate ratio of 1:1.

TABLE VI. Test net results, Namur Lake. August 10 - 14, 1967.

Net Set No.	Duration of set (hours)	Depth fished (feet)	Mesh size (ins.)	Lake whitefish	Lake trout	Tullibee	Totals
67056	13	40-45	3½	6	-	-	6
67056	13	45-50	4½	-	-	-	0
67057	15	8-20	1½	-	-	14	14
67058	17	70-75	4½	-	13	-	13
67058	17	75-80	5½	-	2	-	2
67-59	17	60-65	2½	4	6	-	10
67059	17	65-70	3½	20	3	-	23
67060	16	60	1½	2	1	104	107
67060	16	60-65	2½	7	4	12	23
67060	16	65-70	3½	26	5	-	31
67061	20	60-65	4½	2	7	-	9
67061	20	65-70	5½	-	1	-	1
Totals				67	42	130	239



TABLE VII. Length, weight and maturity of lake trout from Namur Lake, 1967.

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
III+	1	1	0	297			280		
IV+	1	0	0	386			520		
V+	2	2	0	410		410-411	780		740- 820
VI+	3	2	0	454	$\pm 3.3$	449-460	1087	$\pm 64$	980-1200
VII+	7	1	4	506	$\pm 9.4$	475-545	1604	$\pm 132$	1260-2280
VIII+	11	5	10	563	$\pm 8.8$	523-615	2210	$\pm 121$	1770-2820
IX+	9	3	9	624	$\pm 8.2$	595-676	3168	$\pm 208$	2620-4540
X+	4	2	4	656	$\pm 18.7$	605-686	3922	$\pm 108$	3740-4230
XI+	2	2	2	757		750-764	6625		6250-7000
XII+	1	0	1	810			8500		
XIII+	1	0	1	883			9500		

TABLE VIII. Length, weight and maturity of lake whitefish from Namur Lake, 1967.

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
II+	2	1	0	183		179-187	65		60- 70
IV+	3	1	0	262	$\pm 3.5$	255-267	197	$\pm 8.8$	180-210
V+	6	3	0	274	$\pm 3.4$	264-286	215	$\pm 10.9$	180-250
VI+	4	3	2	345	$\pm 7.0$	332-361	430	$\pm 18.7$	390-480
VII+	17	8	13	363	$\pm 2.0$	347-380	532	$\pm 13.7$	410-600
VIII+	25	14	22	379	$\pm 1.6$	360-390	596	$\pm 8.4$	520-690
IX+	3	1	3	384	$\pm 4.6$	376-392	647	$\pm 33.4$	580-680

TABLE IX. Length, weight and maturity of tullibee from Namur Lake, 1967.

Age Class	n	♀♀	No. Mature	Fork length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
II+	13	6	10	183	$\pm 5.6$	148-205	68	$\pm 5.8$	40- 90
III+	13	10	12	217	$\pm 1.9$	205-232	97	$\pm 2.4$	80-110
IV+	16	-	-	264	$\pm 4.6$	226-287	175	$\pm 10.1$	100-220
VI+	1	-	-	312			240		





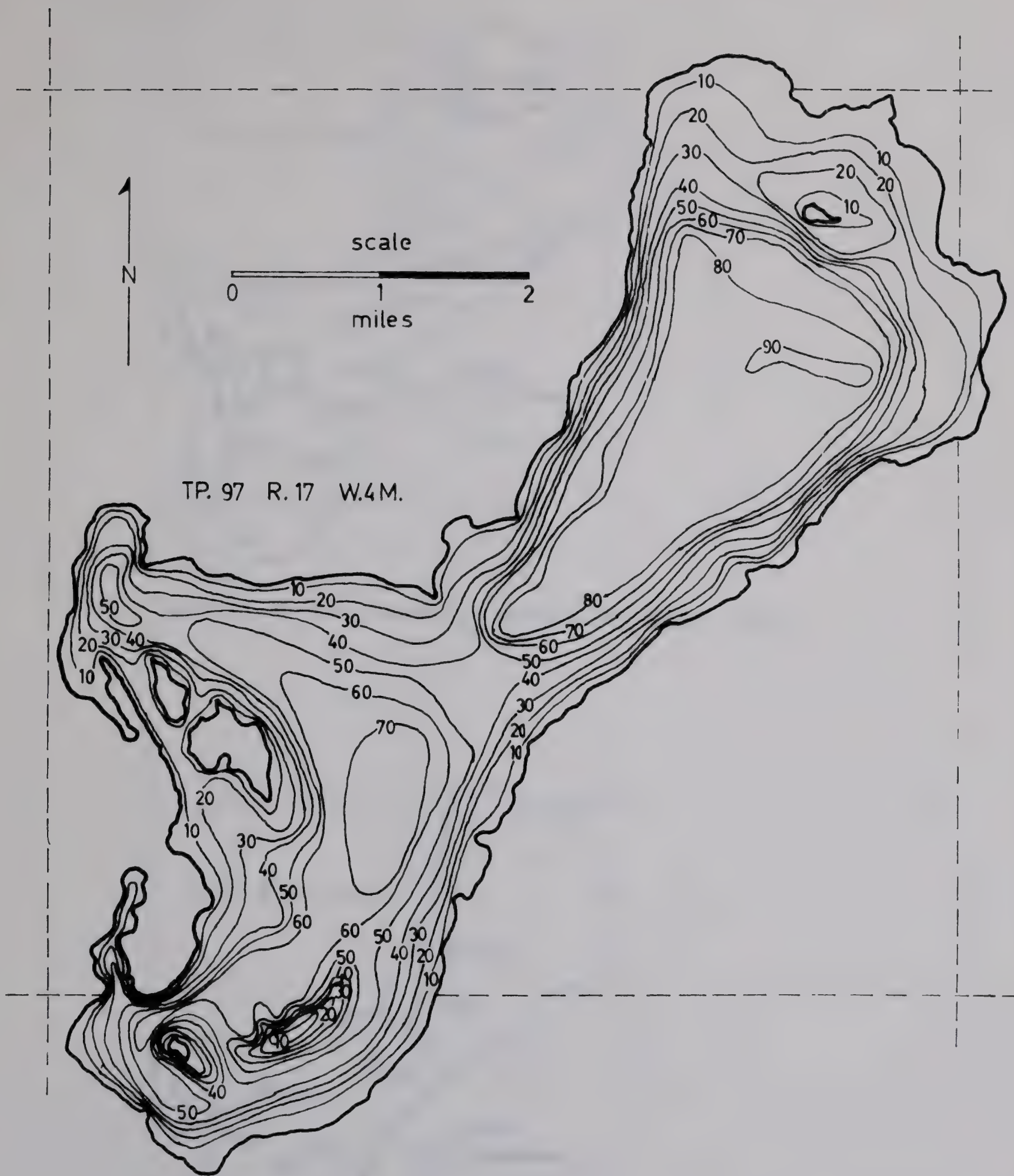


Figure 1. Namur Lake contour map. Contour intervals of 10 feet.



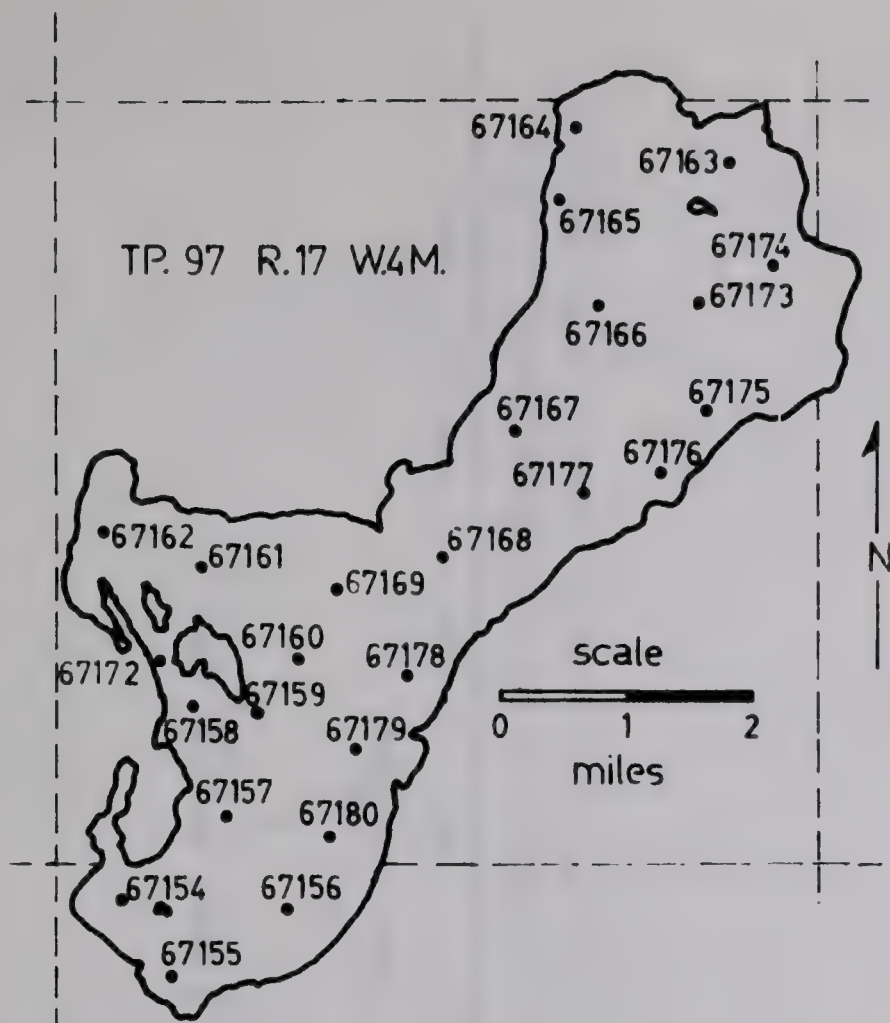


Figure 2. Bottom sampling stations on Namur Lake.

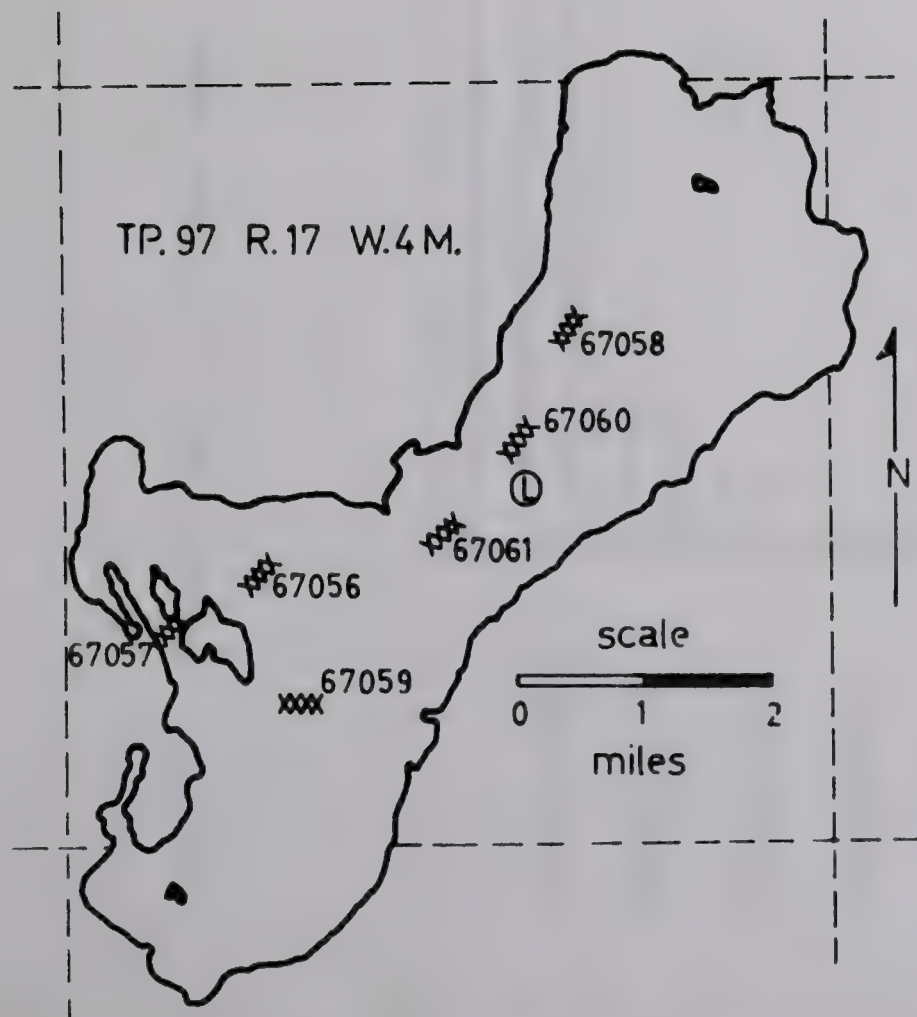


Figure 3. Net sets (xxx) and limnology station ① on Namur Lake.





Figure 4. Composition of bottom fauna from Namur Lake, August 1967.

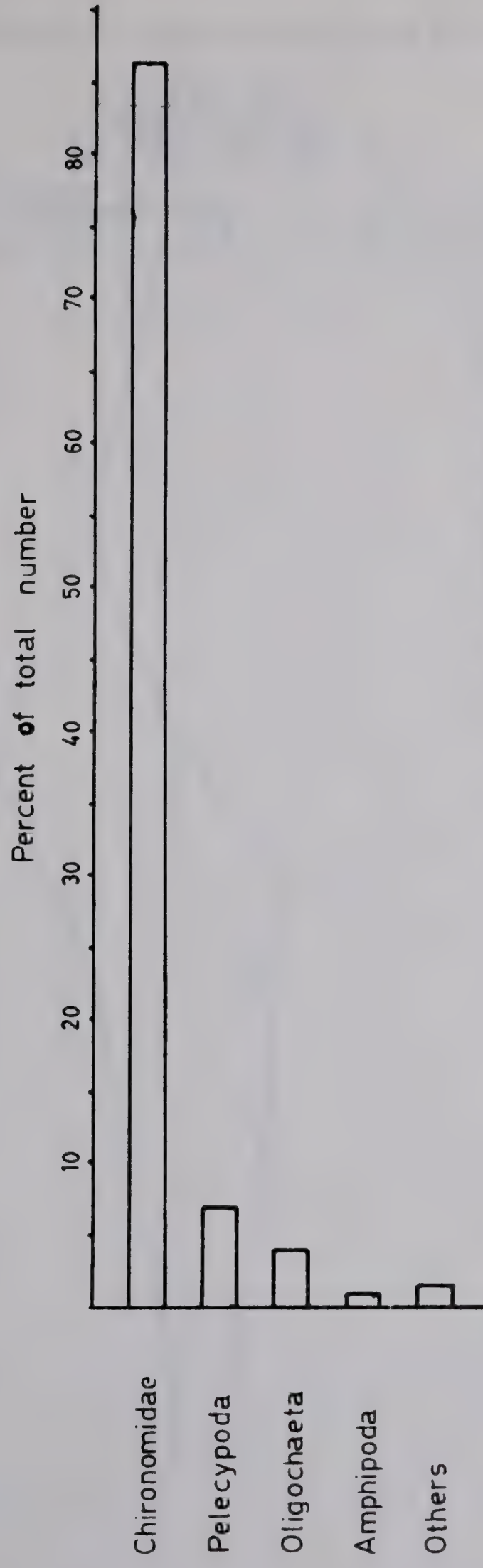






Figure 5. Limnology station on Namur Lake, August 1967.

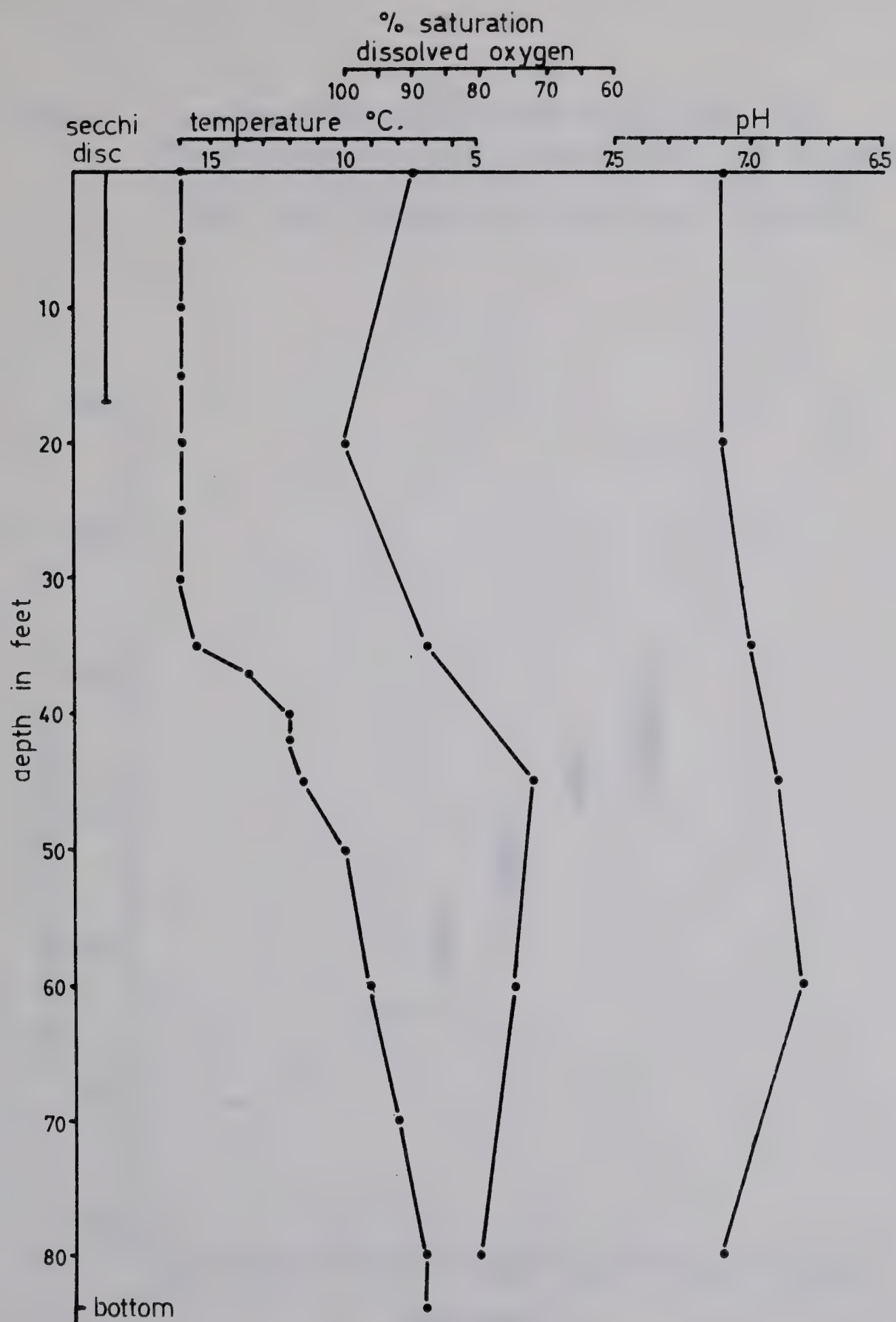




Figure 6. Lake trout from Namur Lake, August 1967. The figure shows the mean, standard error, 95% confidence interval and range of fork lengths for each age class. The number in each age class is indicated.

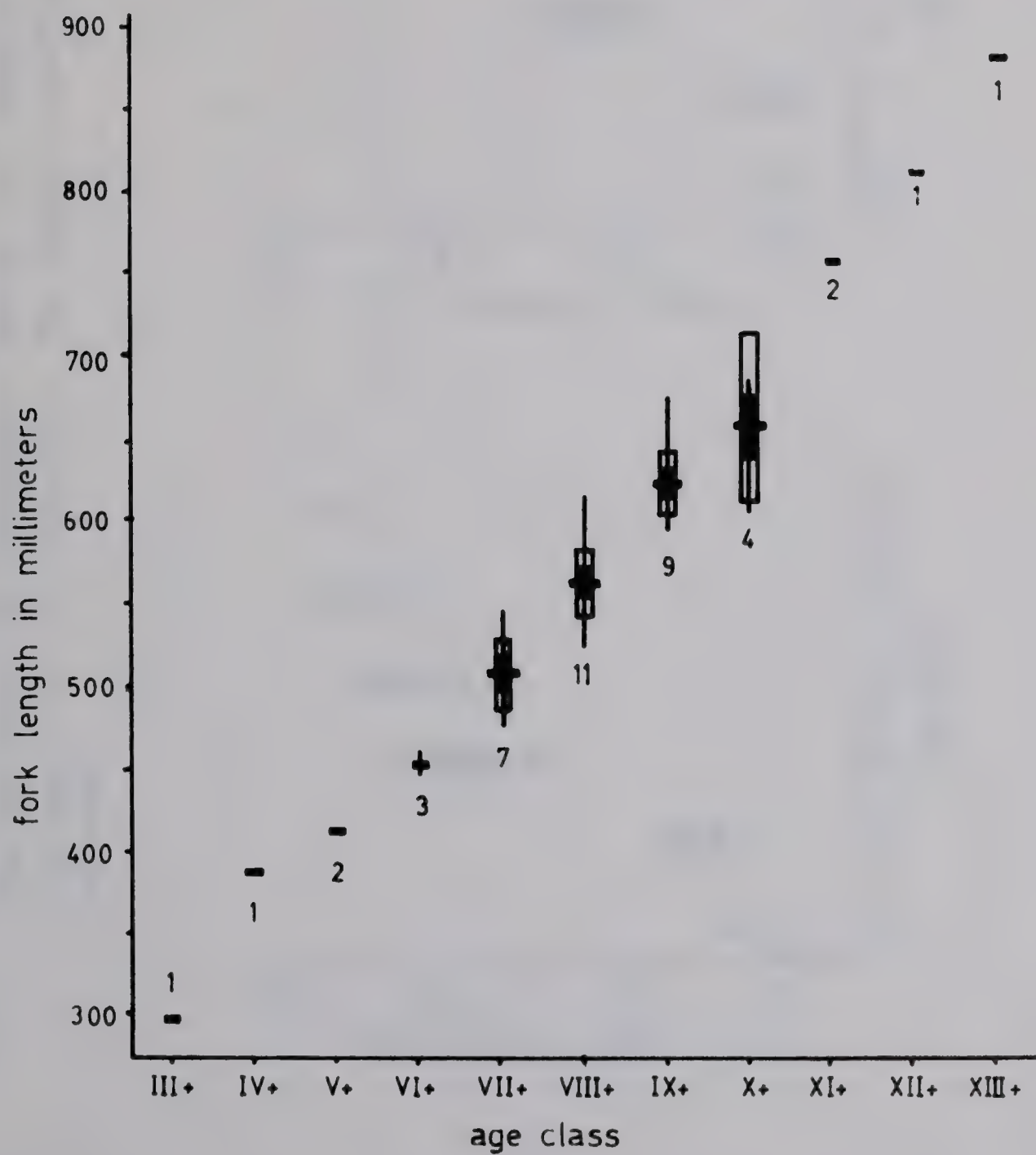






Figure 7. Lake whitefish from Namur Lake, August 1967, showing the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.

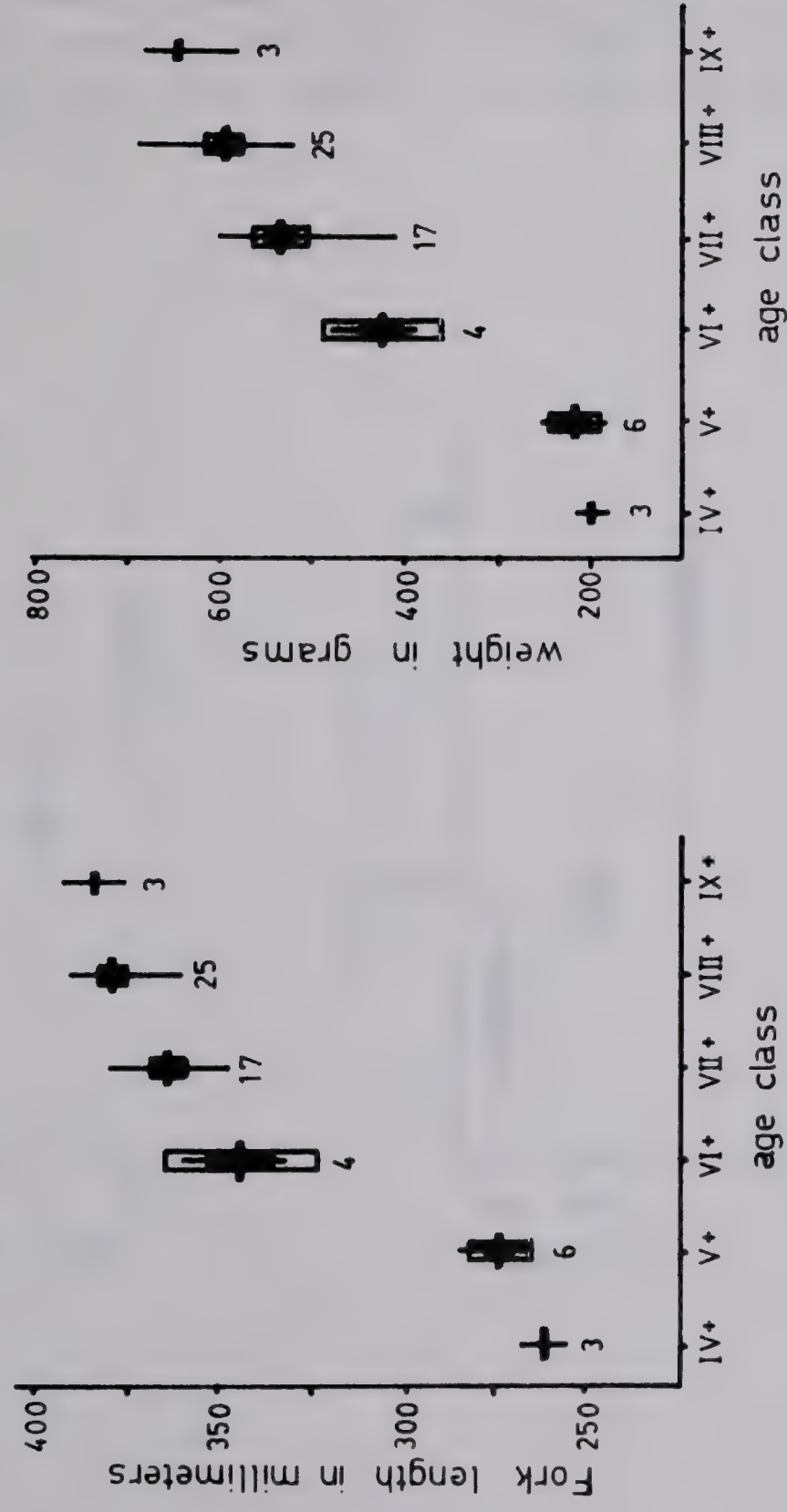
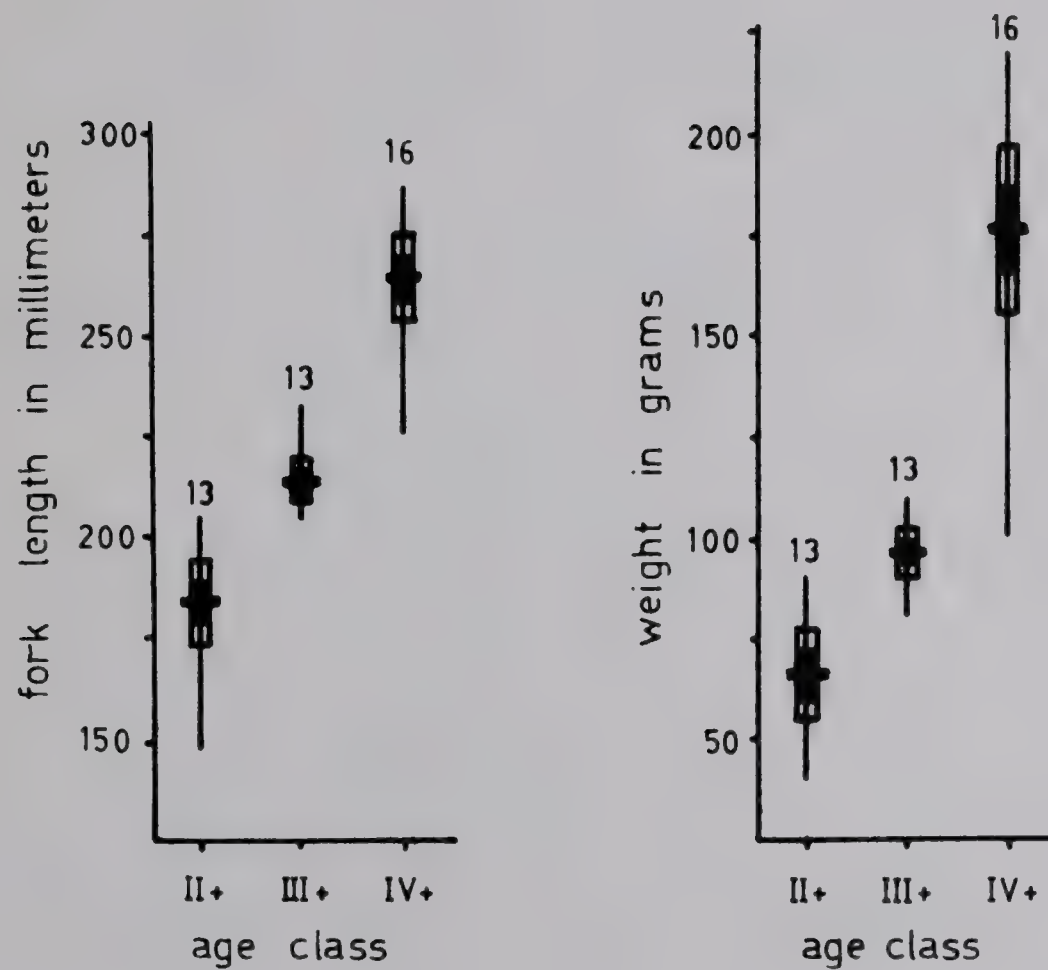






Figure 8. Tullibee from Namur Lake, August 1967, showing the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.



commersoni), burbot (lota lota), and slimy sculpins (Cottus cognatus) were obtained. Only seven arctic grayling were found, while the burbot were quite numerous, although all young-of-the-year, as were the northern pike. Only a few small white suckers and one sculpin were found.

The seven arctic grayling were examined, the fork length, weight, sex and maturity of each being recorded (Table III). They appeared to be quite fast growing and probably spawn at the beginning of their third year. The largest one caught weighed 550 grams.

This stream appears to be relatively unproductive and would provide only a limited number of arctic grayling for angling.

TABLE I. Bottom samples from Unnamed stream entering Namur Lake. Both samples were taken with a square foot surber sampler on August 10, 1967 at stream station #67007. Only the presence (x) or absence (-) of an organism in the sample is indicated.

Group	Organism	Sample No.	
		67170	67171
Hirudinea	<u>Helobdella stagnalis</u>	-	x
Ephemeroptera	<u>Baetis sp.</u>	x	x
	<u>Heptagenia sp.</u>	x	-
Trichoptera	<u>Neureclipsis sp.</u>	x	x
	<u>Glossosoma sp.</u>	x	x
	<u>Brachycentrus sp.</u>	x	-
Diptera	<u>Simulium sp.</u>	x	x
	Chironomidae	-	x



TABLE II. Water chemistry, Unnamed stream entering Namur Lake. Both samples were taken on August 10, 1967 at stream station #67007.

Sample No.	67045	67046
Temperature ( $^{\circ}\text{C}$ )	18	18
Dissolved oxygen (ppm)	9	9
Total alkalinity (ppm $\text{CaCO}_3$ )	20	20
Calcium hardness (ppm $\text{CaCO}_3$ )	10	10
Total hardness (ppm $\text{CaCO}_3$ )	15	15
pH (Hellige)	6.6	6.6
Conductivity (mmhos/cm @ $18^{\circ}\text{C}$ )	32	30

TABLE III. Lengths and weights of Arctic grayling from unnamed stream entering Namur Lake, collected on August 10, 1967 at stream station #67007.

Age Class	n	Fork length (mm)		Weight (gms)	
		x	range	x	range
I	1	190		70	
II	2	238	233-244	165	160-170
III	1	310		340	
IV	2	358	345-370	420	370-470
V	1	363		550	

### NAMUR RIVER

The Namur River, located in the Birch Mountains, drains Namur Lake into Gardiner Lake. It has a total length of about five miles and an average gradient of approximately 10 feet per mile.

One stream station (#67008) was taken at the origin of the river on August 15, 1967 (Figure 1). The river here was from 20 to 50 feet wide and had a mean width of about 30 feet. The mean depth was between two and three feet. Pools were quite frequent, with about a 50:50 pool to riffle ratio. Many pools were quite large and most had good cover. Bank cover was good and there did not appear to be any great water level fluctuation. The bottom consisted mostly of organic mud and detritus with some sand and clay. Further downstream, gravel, small rubble and sand predominated on the bottom.

Aquatic vegetation was abundant in the stream and bottom fauna were sampled with a dip net. The results are summarized in Table 1. Oligochaets predominated in the section sampled but a fair number of groups was present. The productivity of this stream is probably improved by the plankton flowing from Namur Lake.

Two water samples were collected at the station on August 15, 1967. The alkalinity was quite low, as was the hardness, while the pH was slightly alkaline and the conductivity ranged from 46 to 48  $\mu\text{mhos/cm}$  @18°C (Table II).

The river was treated with rotenone to determine the fish species present. The most abundant species was the arctic grayling (Thymallus arcticus). Burbot (Lota lota) and northern pike (Esox lucius) were quite abundant, most being young-of-the-year.

Longnose suckers (Catostomus catostomus) were found in good numbers while white suckers (Catostomus commersoni) and lake whitefish (Coregonus clupeaformis) were scarce. Only one slimy sculpin (Cottus cognatus) was found.

Thirty-five arctic grayling were examined, the fork length, weight, sex and maturity of each being recorded. Scale samples were taken for age determination (Table III, Figure 2). These fish appear to be quite fast growing and reach a good size, the largest in the sample weighing 800 grams. They probably spawn for the first time at the beginning of their third year. These fish should provide excellent sport fishing.

The Namur River appears to have a good population of arctic grayling and should support a moderate level of sport fishing.



TABLE I. Bottom Fauna of the Namur River, sampled at stream station #67008 on August 15, 1967 with an aquatic dip net. Only the presence (x) or absence (-) of an organism is noted.

Group	Organism	Sample No.		
		67021	67022	67023
Oligochaeta	Lumbriculidae	x	x	x
	Tubificidae	-	-	x
Hirudinea	<u>Helobdella stagnalis</u>	-	x	-
Amphipoda	<u>Hyallela azteca</u>	x	x	x
Ephemeroptera	<u>Caenis sp.</u>	x	x	-
	<u>Paraleptophlebia sp.</u>	x	x	-
Trichoptera	<u>Neureclipsis sp.</u>	x	x	-
	<u>Glossosoma sp.</u>	x	-	-
	<u>Limnephilus sp.</u>	-	x	-
Diptera	Chironomidae	-	x	x
Hemiptera	Corixidae	-	-	x
Pelecypoda	Sphaeriidae	x	x	x
Gastropoda	Planorbidae	x	-	-



TABLE II. Water chemistry, Namur River. Both samples were taken at stream station #67008 on August 15, 1967.

Sample No.	67047	67048
Temperature ( $^{\circ}\text{C}$ )	15.5	16.0
Dissolved Oxygen (ppm)	9.0	9.0
Total alkalinity (ppm $\text{CaCO}_3$ )	35	25
Ca Hardness (ppm $\text{CaCO}_3$ )	15	15
Total Hardness (ppm $\text{CaCO}_3$ )	25	25
pH (Hellige)	7.3	7.4
Conductivity (mmhos/cm @18 $^{\circ}\text{C}$ )	48	46

TABLE III. Lengths and weights of Arctic grayling from Namur River, collected on August 15, 1967.

Age Class	n	Fork Length (mm)			Weight (gms)		
		$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
I+	1	200			100		
II+	5	273	$\pm 4.0$	261-284	276	$\pm 19.6$	220-340
III+	6	351	$\pm 5.5$	333-370	583	$\pm 36.9$	460-700
IV+	16	361	$\pm 7.5$	335-465	608	$\pm 17.1$	480-730
V+	7	380	$\pm 8.2$	340-400	651	$\pm 50.3$	460-800

Figure 1. Locations of stream stations on the Namur River and a small stream entering Namur Lake.

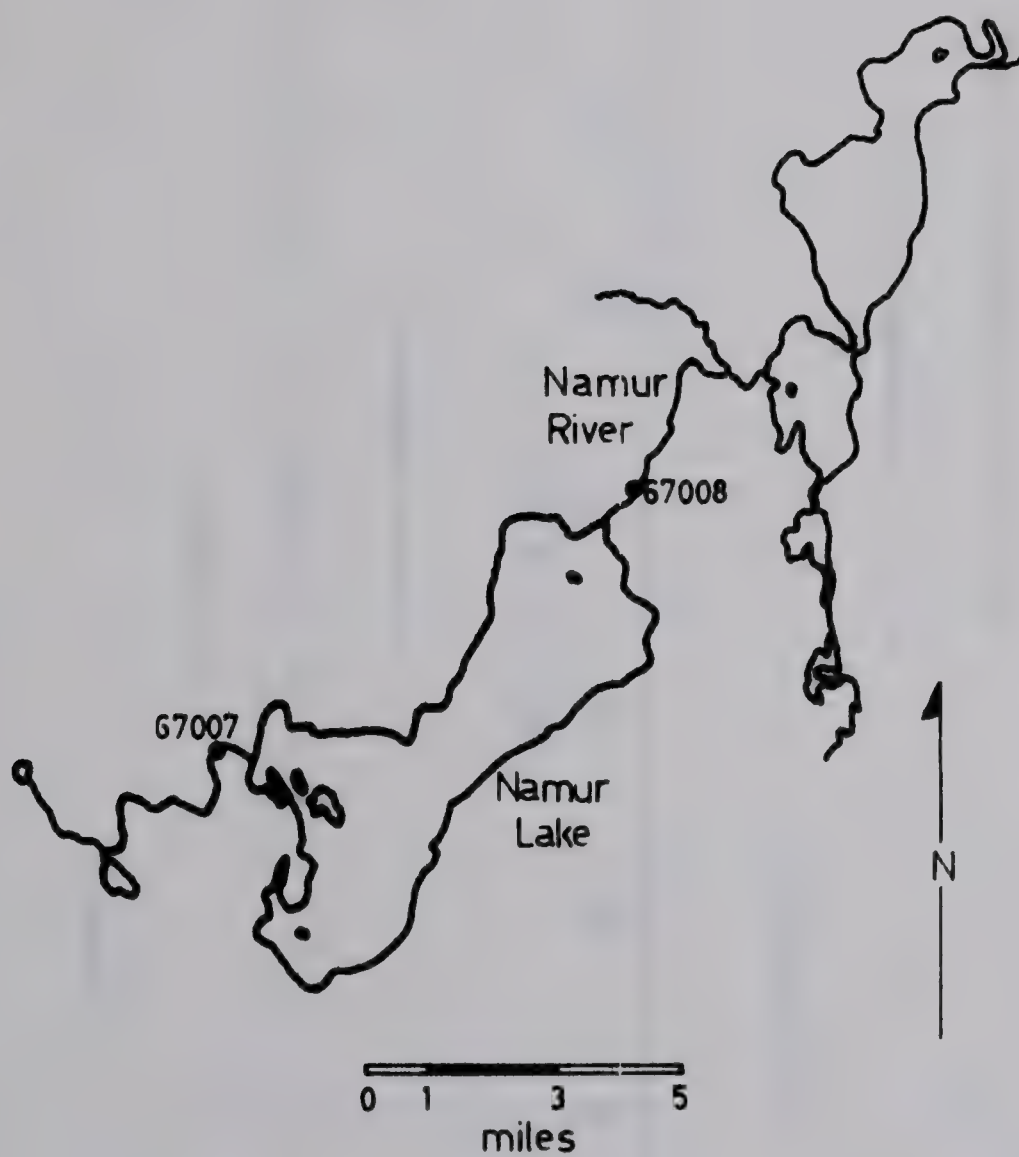
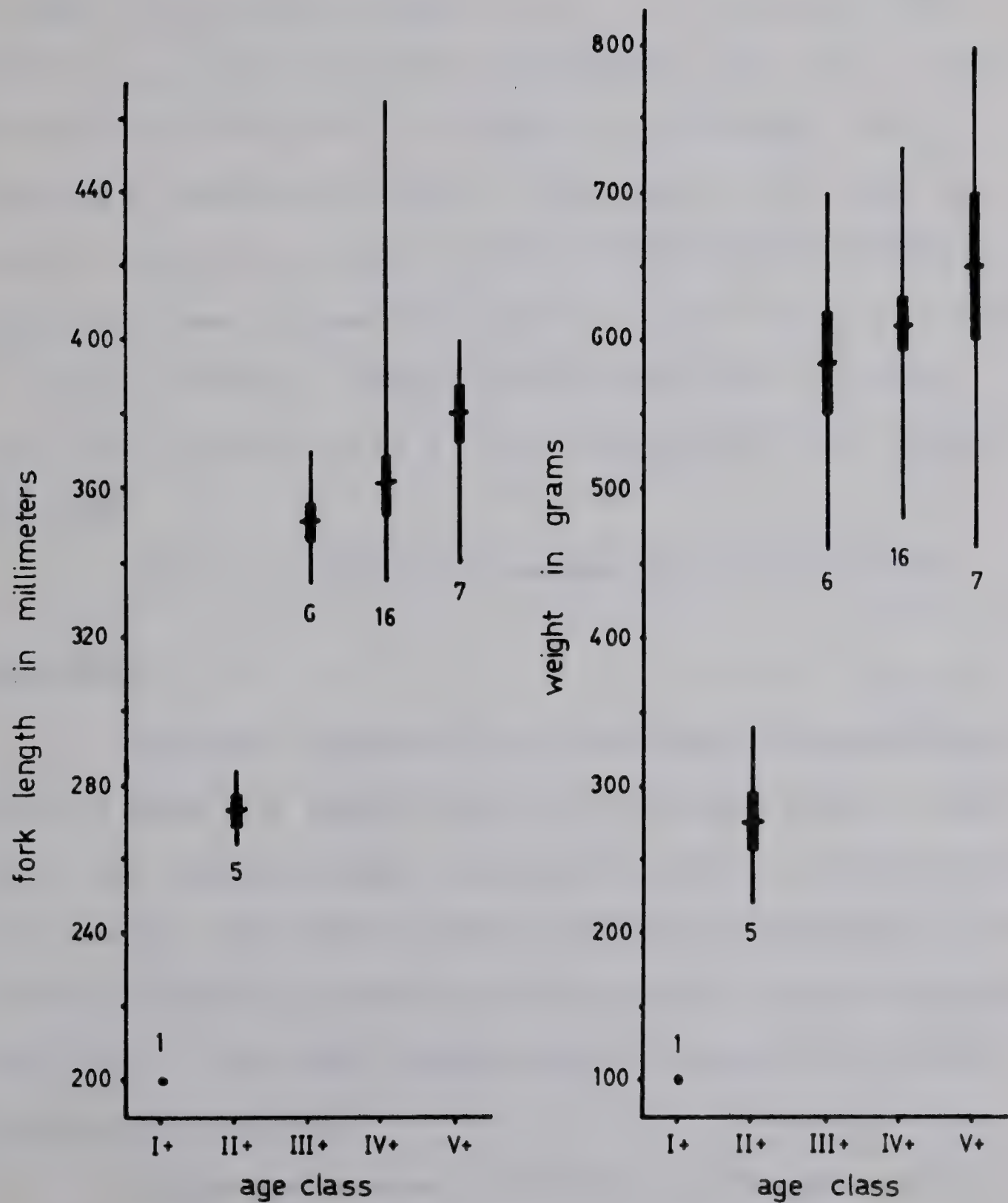




Figure 2. Arctic grayling from the Namur River, August 1967. The figures show the mean, standard error and range in fork length and weight for each age class. The number in each age class is indicated.







## GARDINER LAKE

### INTRODUCTION

Gardiner Lake is located in the Birch Mountains about 90 air miles northwest of Ft. McMurray, Alberta, in Township 98, Range 16, West of the Fourth Meridian. It lies at a latitude of about  $57^{\circ} 30' \text{ N.}$ , and at an altitude of approximately 2220 feet. It is drained by the Ells River, a tributary of the Athabasca River. This area is inaccessible except by float plane in the summer but could be reached by dog team or tracked vehicles during the winter. Gardiner Lake was surveyed from August 21 to 28, 1967, to determine its fishery potential. Men and equipment were flown in using a light plane on floats and as a result survey methods were somewhat restricted.

There is no record of commercial fishing on this lake.

### MORPHOMETRY

The area of Gardiner Lake, determined by planimeter from maps at a scale of 1 inch to 1 mile, is 9.30 square miles or 5,952 acres. The shoreline length (including the shoreline of two islands) is 24.5 miles. The shoreline development factor (comparison of actual shoreline length to the shortest length that would enclose the same area) is 2.3. This means that the lake has a moderately irregular shoreline (see Table I).

Depths were measured with an echo sounder and a contour map was constructed from the results. The volume is estimated to be in the order of 117,000 acre-feet, which gives a mean depth of 20

feet, while the maximum depth found was 45 feet. From the depth distribution it can be seen that most of the lake is quite shallow and about 75% is in the euphotic zone (less than 30 feet).

The maximum length of the lake, in a north-south direction, is 7.5 miles, while the maximum effective length (the longest stretch of open water with no obstruction to wind action) is 5.2 miles and the maximum width is 2.5 miles. There is good wind action on the lake which probably keeps the lake well mixed and does not allow stable thermal stratification.

#### PHYSICAL AND CHEMICAL FEATURES

Limnological observations were made on August 28, 1967 (Figure 3, Table III). There was no thermal stratification and no oxygen depletion at 35 feet (depth at the station was 37 feet). The lake was well mixed by the wind and it is probable that stable thermal stratification rarely occurs. The secchi disc visibility was 8 feet and this was reduced largely because of a plankton "bloom" in progress at the time of the survey, although the water did have a slight brown color.

Four water samples were taken at the limnology station. The total alkalinity ranged from 60 to 75 ppm as  $\text{CaCO}_3$ . The calcium hardness was 40 ppm while the total hardness ranged from 45-50 ppm as  $\text{CaCO}_3$ . Thus the water was quite soft. The pH was slightly alkaline, being 7.5 in all samples and the conductivity, standardized to  $18^\circ\text{C}$ , ranged from 98 to 107 mmhos/cm. This is relatively high for lakes in Northern Alberta (Table IV).

The limnology and water chemistry indicate a fair potential for production in this lake.



## BOTTOM FAUNA

Twenty-five bottom samples were taken, each sample consisting of one dredging with a 6-inch square Ekman dredge at each location (see Figure 2). The samples were washed through a screen bottomed bucket (25 meshes per inch) and all living organisms were preserved. These samples were analyzed later in the laboratory (Table II).

Most of the lake bottom consisted of organic muck while most of the shoreline was of sand or gravel and aquatic vegetation was quite extensive in the shallow areas (less than 15 feet).

From the bottom samples, the standing crop of bottom fauna is estimated to be 5593 organisms per square meter with a volume displacement of 25.75 cc. per square meter. Chaoborus and chironomids were the dominant organisms, Chaoborus being the most numerous but the chironomids having the greatest volume displacement. Also present were oligochaetes, amphipods and pelecypods (all sphaeriids). Other organisms were insignificant in number and volume (Figure 4).

The amount and type of bottom organisms found indicate a relatively high level of productivity in this lake.

## PLANKTON

Four vertical plankton hauls were made with a Wisconsin-type plankton net (mouth diameter of 20 cm) at the limnology station on August 28, 1967. An extensive plankton bloom was in progress at the time of the survey and large numbers of Nostoc were noticed washed up on shore.

The most abundant phytoplankters were the blue green algae, particularly Aphanizomenon and Anabaena, typical of fall "blooms".



Diatoms were also quite abundant, in particular Melosira, Tabellaria and Fragilaria. The Dinoflagellates (Ceratium) were also abundant but green algae were rare (Table V).

Zooplankters constituted a relatively small portion of the net plankton. Rotifers (two species) were abundant, as were copepods (both adults and nauplii), while the cladocerans were less abundant.

The nature and extent of this fall plankton bloom would indicate that this lake is eutrophic in nature.

#### FISH FAUNA

Net sets were made using each of the following mesh sizes (stretch measure):  $1\frac{1}{2}$ ,  $2\frac{1}{2}$ ,  $3\frac{1}{2}$ ,  $4\frac{1}{2}$  and  $5\frac{1}{2}$  inches. All nets were 100 yards in length except the  $1\frac{1}{2}$  inch mesh net which was 50 yards in length (Table VI).

Fish caught in the nets included walleye (Stizostedion vitreum), northern pike (Esox lucius), lake whitefish (Coregonus clupeaformis), tullibee (Coregonus artedii), perch (Perca flavescens), white suckers (Catostomus commersoni) and longnose suckers (Catostomus catostomus). No poisoning or seining was carried out in this lake for small fish.

#### Walleye

Eighty-three walleye were examined, the fork length, weight, sex and maturity recorded for each. Scale samples were taken for age determination.

These fish ranged from one to eight years in age, with those in their sixth year being most abundant in the catch. These

fish appear to be quite fast growing for walleye, the largest in the sample weighing 3250 grams at seven years of age. There is a clear sexual dimorphism, the females being noticeably larger than the males at the same age (Table VII, Figure 5).

These fish are maturing in their fifth year but probably do not spawn until their sixth year. There appears to be adequate spawning habitat for walleyes in this lake.

The stomachs of thirty walleyes were examined, but most of these were empty or contained partly digested material, while fish remains in the remaining stomachs could not be identified. It would, however, appear that small fish are their main food item.

Ten walleye were examined for plerocercoids of Diphylllobothrium latum. Four were found to be infected; two with one cyst each and two with two cysts each. Infestation with this parasite is not likely to detract from their sport fishery value.

#### Northern pike

Forty northern pike were examined, the fork length, weight, sex, and maturity recorded for each. Scale samples were taken for age determination.

These fish ranged from four to eight years of age, with those in age class VII being most abundant in the sample. They appear to be fast growing for northern pike, the largest weighing 3370 gms at eight years of age (Table VIII, Figure 6). These fish mature early and are probably spawning during their fourth year. There appears to be adequate spawning habitat for the species.



The stomachs of all the pike were examined and most of them contained fish, particularly lake whitefish and tullibee.

The northern pike could support a good sport fishery in Gardiner Lake.

#### Lake whitefish

Sixty-seven lake whitefish were examined, their fork lengths, weights, sex and maturity recorded. Scale samples were taken for age determination.

These fish ranged from two to twelve years in age, with age class VIII being most abundant in the sample. They appear to have a good growth rate for lake whitefish, weighing about 1500 grams at age VIII (see Table IX, Figure 7).

The lake whitefish are maturing in their sixth and seventh years but most are not spawning until their seventh year. The spawning habitat appears to be quite adequate for this species.

Twenty lake whitefish were examined for plerocercoids of Triaenophorus crassus. Nineteen (95%) were infected with a total of 135 cysts. Their total weight was 62.23 pounds, giving a rate of infestation of 217 cysts per 100 pounds of fish. This is far too high for these fish to be of much value on the commercial market.

#### Tullibee

Five tullibee were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination.

They ranged in age from two to five years but were quite

small, the largest weighing 180 grams (Table X). They appeared to spawn in their third year. There are probably adequate spawning grounds for tullibee in this lake. These fish provide good forage for walleye and northern pike.

### Suckers

Two species of suckers were taken in Gardiner Lake, the white sucker and the longnose sucker. These fish did not appear to be very plentiful in this lake. Tabulated information on the specimens taken is presented in Tables XI and XII.

### Perch

Four perch were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination.

These fish were very small, weighing 140 to 150 grams at the age of five years. They are mature in their fifth year and probably spawn that year (Table XIII).

This species is probably not very plentiful in Gardiner Lake and has little value for a fishery.

### DISCUSSION AND CONCLUSION

Using the morpho-edaphic index of Ryder (1965), a total annual production of  $4\frac{1}{2}$  pounds per acre is postulated. This is probably a little low and an estimated annual production of five pounds per acre is suggested, or about 30,000 pounds of fish per year, consisting primarily of northern pike, walleye, tullibee and whitefish. About 10,000 pounds of this production would consist of walleye and northern pike. The remainder would be whitefish and



tullibee.

Since this lake contains fair populations of two species of sport fish, both species exhibiting good growth rates, it has a good potential as a sport fishery. The commercial fishery potential is, however, quite low, largely because the lake whitefish are highly infested with plerocercoids of Triaenophorus crassus. The tullibee and other species are of too little value to be harvested economically at present.

It is recommended that this lake be reserved for a sport fishery.

TABLE I. Morphometry of Gardiner Lake.

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LOCATION: Tp. 99 - R.16 - W4M; Tp. 98 - R.16 - W4M.

AREA: 9.30 mi<sup>2</sup> (5952 a.)

VOLUME: 117,000 acre feet

SHORELINE: 24.5 miles

SHORELINE DEVELOPMENT FACTOR: 2.3

MAXIMUM LENGTH: 7.5 miles

MAXIMUM EFFECTIVE LENGTH: 5.2 miles

MAXIMUM WIDTH: 2.5 miles

MAXIMUM EFFECTIVE WIDTH: 2.5 miles

MEAN WIDTH: 1.2 miles

MAXIMUM DEPTH: 45 feet

MEAN DEPTH: 20 feet

DEPTH DISTRIBUTION:

SURFACE AREA:	9.30 mi <sup>2</sup>	(5952 a.)	= 100%	surface area
10 FEET PLUS:	6.50 mi <sup>2</sup>	(4160 a.)	= 70%	surface area
20 FEET PLUS:	3.73 mi <sup>2</sup>	(2387 a.)	= 40%	surface area
30 FEET PLUS:	2.33 mi <sup>2</sup>	(1491 a.)	= 26%	surface area
40 FEET PLUS:	1.88 mi <sup>2</sup>	(1203 a.)	= 20%	surface area

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TABLE II. Bottom fauna of Gardiner Lake.

Station No.	Depth (feet)	Substrate	Ephemeroptera	Trichoptera	Chironomidae	Chaoborus	Oligochaeta	Amphipoda	Pelecypoda	Gastropoda	Others	Totals	Displaced Volume (c.c.)
67185	2	sand	8	-	10	-	-	36	-	16	-	70	0.90
67181	6	clay	2	2	26	-	5	11	6	-	4	56	0.35
67206	99	muck	-	-	64	-	3	-	4	3	-	74	0.20
67207	9	muck	-	-	82	-	10	15	-	-	3	110	1.20
67208	9	muck	-	-	104	-	2	-	4	1	-	111	0.25
67182	12	clay	-	-	92	-	-	1	12	-	-	105	0.35
67183	13	clay	-	-	60	-	1	-	5	4	-	70	0.25
67184	15	clay	-	-	32	2	4	-	9	2	11	60	0.40
67189	15	muck	-	-	44	74	1	-	15	2	-	136	0.75
67195	18	sand	-	-	2	-	-	-	5	-	1	8	0.05
67196	18	muck	-	-	93	10	1	-	6	-	-	110	1.30
67197	22	muck	-	-	48	4	5	-	5	1	-	63	0.50
67190	24	muck	-	-	24	20	-	-	10	2	-	56	0.50
67201	24	muck	-	-	31	15	4	-	6	-	-	56	0.25
67198	29	muck	-	-	50	20	3	-	8	2	-	83	0.90
67204	29	muck	-	-	52	10	3	-	7	33	-	75	0.30
67199	30	muck	-	-	60	40	25	-	5	-	-	130	0.70
67200	30	muck	-	-	60	3	8	-	6	10	-	87	0.45
67191	33	muck	-	-	15	1200	-	-	1	2	4	1221	1.10
67192	36	muck	-	-	73	11	-	-	2	3	-	89	0.85
67193	36	muck	-	-	93	7	-	-	12	-	-	112	0.55
67194	39	muck	-	-	34	86	5	-	7	1	-	133	1.15
67202	39	muck	-	-	50	7	-	-	5	-	1	63	0.40
67205	40	muck	-	-	50	16	20	-	2	-	-	88	0.60
67203	42	muck	-	-	58	12	2	-	9	-	-	81	0.70

TABLE III. Physical observations in Gardiner Lake, August 28, 1967.

Depth (feet)	Temperature (°C)	Dissolved Oxygen Conductivity			pH
		ppm	% saturation	(mmhos/cm)	
0	16	8	80	98	7.5
5	16				
10	16	8	80	98	7.5
15	16				
20	16	8	80	100	7.5
25	16				
30	16				
35	15.5	8	80	107	7.5
37	15.5				



TABLE IV. Water chemistry, Gardiner Lake. Four samples were taken at the limnology station on August 28, 1967.

Sample No.	67081	67082	67083	67084
Depth (feet)	0	10	20	35
Temperature ( $^{\circ}\text{C}$ )	16	16	16	15.5
Dissolved oxygen (ppm)	8	8	8	8
Phenolphthalein alkalinity (ppm $\text{CaCO}_3$ )	0	0	0	0
Total alkalinity (ppm $\text{CaCO}_3$ )	75	75	75	60
Calcium hardness (ppm $\text{CaCO}_3$ )	40	40	40	40
Total hardness (ppm $\text{CaCO}_3$ )	45	45	50	45
pH (Hellige)	7.5	7.5	7.5	7.5
Conductivity (mmhos/cm @18 $^{\circ}\text{C}$ )	98	98	100	107

TABLE V. Plankton from Gardiner Lake, August 28, 1967.

PHYTOPLANKTON

<u>GROUP</u>	<u>ORGANISMS</u>	<u>RELATIVE ABUNDANCE</u>
Cyanophyta	<u>Aphanizomenon</u>	Very abundant
	<u>Anabaena</u>	Very abundant
	<u>Gomphosphaeria</u>	Common
Chlorophyta	<u>Staurostrum</u>	Rare
	<u>Spirogyra</u>	Rare
Chrysophyta	<u>Melosira</u>	Abundant
	<u>Tabellaria</u>	Common
	<u>Fragilaria</u>	Common
	<u>Asterionella</u>	Rare
Pyrrhophyta	<u>Ceratium</u>	Common

ZOOPLANKTON

<u>GROUP</u>	<u>ORGANISMS</u>	<u>RELATIVE ABUNDANCE</u>
Rotifers	<u>Keratella</u>	Abundant
	<u>Kellikottia</u>	Abundant
Cladocera		Common
Copepoda		Abundant

TABLE VI. Test net results, Gardiner Lake, August 22 - 25, 1967.

Net Set No.	Duration of set (hrs.)	Depth Fished (feet)	Mesh Size (ins.)	Lake Whitefish	Walleye	Northern Pike	Tullibee	Perch	Suckers	Totals
67062	17	20	4½	30	50	23	-	-	2	105
67062	17	25	5½	60	32	-	-	-	1	93
67063	2	7-10	2½	-	2	4	-	1	1	8
67063	2	10	3½	1	1	4	-	-	-	6
67064	4	10	1½	1	11	-	2	2	-	16
67064	4	10-15	2½	5	7	1	3	1	-	17
67064	4	15	3½	-	15	9	-	-	-	24
----- Totals				97	118	41	5	4	4	269



TABLE VII. Length, weight and maturity of walleye from Gardiner Lake. Eighty-three fish were examined, their ages determined from scale samples. The fish were taken on August 22 to 25, 1967 by gill nets. (See Figure 5).

Age Class	Sex	n	No. Mature	Fork Length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
I+	both	6	0	168 $\pm$ 5.7		150-190	50 $\pm$ 2.6		40-60
II+	both	3	0	241		232-250	143		130-160
III+	both	4	0	337 $\pm$ 17.3		290-367	415 $\pm$ 67.0		201-629
IV+	both	8	0	380 $\pm$ 8.5		345-414	622 $\pm$ 40.7		420-760
V+	♂	6	4	462 $\pm$ 13.1		409-500	1138 $\pm$ 69.9		820-1280
V+	♀	2	1	508		486-530	1525		1200-1850
VI+	♂	12	11	530 $\pm$ 4.7		504-552	1750 $\pm$ 62.6		1470-2020
VI+	♀	23	23	556 $\pm$ 5.0		511-595	2050 $\pm$ 52.3		1680-2570
VII +	♂	5	5	567 $\pm$ 9.5		549-600	2150 $\pm$ 112.8		1860-2520
VII+	♀	11	11	617 $\pm$ 5.2		593-650	2735 $\pm$ 77.8		2400-3250
VIII+	♂	1	1	520			1840		
VIII+	♀	2	2	610			2910		2790-3030

TABLE VIII. Length, weight and maturity of northern pike from Gardiner Lake. Forty fish were examined, their ages determined from scale samples. The fish were taken on August 22 - 25, 1967 by gill nets. (See Figure 6).

Age Class	n	No. ♀	No. ♂	Fork Length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
IV +	1	1	1	525			940		
V+	3	1	3	555 $\pm$ 11.8		535-576	1110 $\pm$ 58		1000-1200
VI +	8	5	6	605 $\pm$ 5.8		570-628	1498 $\pm$ 45		1320-1700
VII+	19	14	18	667 $\pm$ 7.5		620-720	1919 $\pm$ 70		1320-2440
VIII +	9	7	9	742 $\pm$ 9.8		690-784	2793 $\pm$ 158		1870-3370

TABLE IX. Length, weight and maturity of lake whitefish from Gardiner Lake. Sixty-seven fish were examined. The fish were collected on August 22 - 25, 1967 (see Figure 7.)

Age Class	n	No. ♀♀	No. Mature	Fork Length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
II+	1	-	0	186			70		
III+	2	1	0	248		242-253	160		140-180
IV+	2	1	0	286		276-295	260		220-300
V+	1	1	0	315			380		
VI+	8	4	2	379	$\pm 7.1$	341-400	715	$\pm 28.1$	580-850
VII+	10	5	9	431	$\pm 4.2$	405-454	1152	$\pm 46.3$	820-1330
VIII+	21	16	21	462	$\pm 2.9$	441-486	1460	$\pm 39.8$	1230-2000
IX+	12	8	12	478	$\pm 5.4$	441-509	1600	$\pm 77.9$	1160-2170
X +	8	7	8	507	$\pm 2.9$	490-518	1945	$\pm 56.8$	1720-2250
XI+	1	1	1	518			1880		
XII+	1	1	1	567			2680		

TABLE X. Length, weight and maturity of tullibee from Gardiner Lake. Five fish were examined. All were caught August 25, 1967.

Age Class	n	No. ♀♀	No. Mature	Fork Length (mm)		Weight (gms)
				mean	range	mean
II+	1	-	-	143		40
III+	1	0	1	186		80
IV+	2	1	2	212	211-214	120
V+	1	1	1	246		180

TABLE XI. Length, weight and maturity of white suckers from Gardiner Lake. Two fish were examined. The specimens were collected August 22, 1967.

Age Class	Number	No. of Females	No. Mature	Fork Length (mm)	Weight (gms)
IV+	1	1	0	317	380
VI+	1	1	1	440	1150

TABLE XII. Length, weight and maturity of longnose suckers from Gardiner Lake. Two fish were examined. The specimens were collected on August 22 to 24, 1967.

Age Class	Number	No. of Females	No. Mature	Fork Length (mm)	Weight (gms)
V+	1	1	1	540	2000
VI+	1	1	1	505	2470

TABLE XIII. Length, weight and maturity of perch from Gardiner Lake. Four perch were examined. The specimens were collected on August 25, 1967.

Age Class	No.	No. of Females	No. Mature	Fork Length (mm)		Weight (gms)	
				mean	range	mean	range
III+	2	-	0	131	127-135	28	25-30
V+	2	1	2	214	211-216	145	140-150







FIGURE 1. Gardiner Lakes contour map, constructed from soundings made during August, 1967.

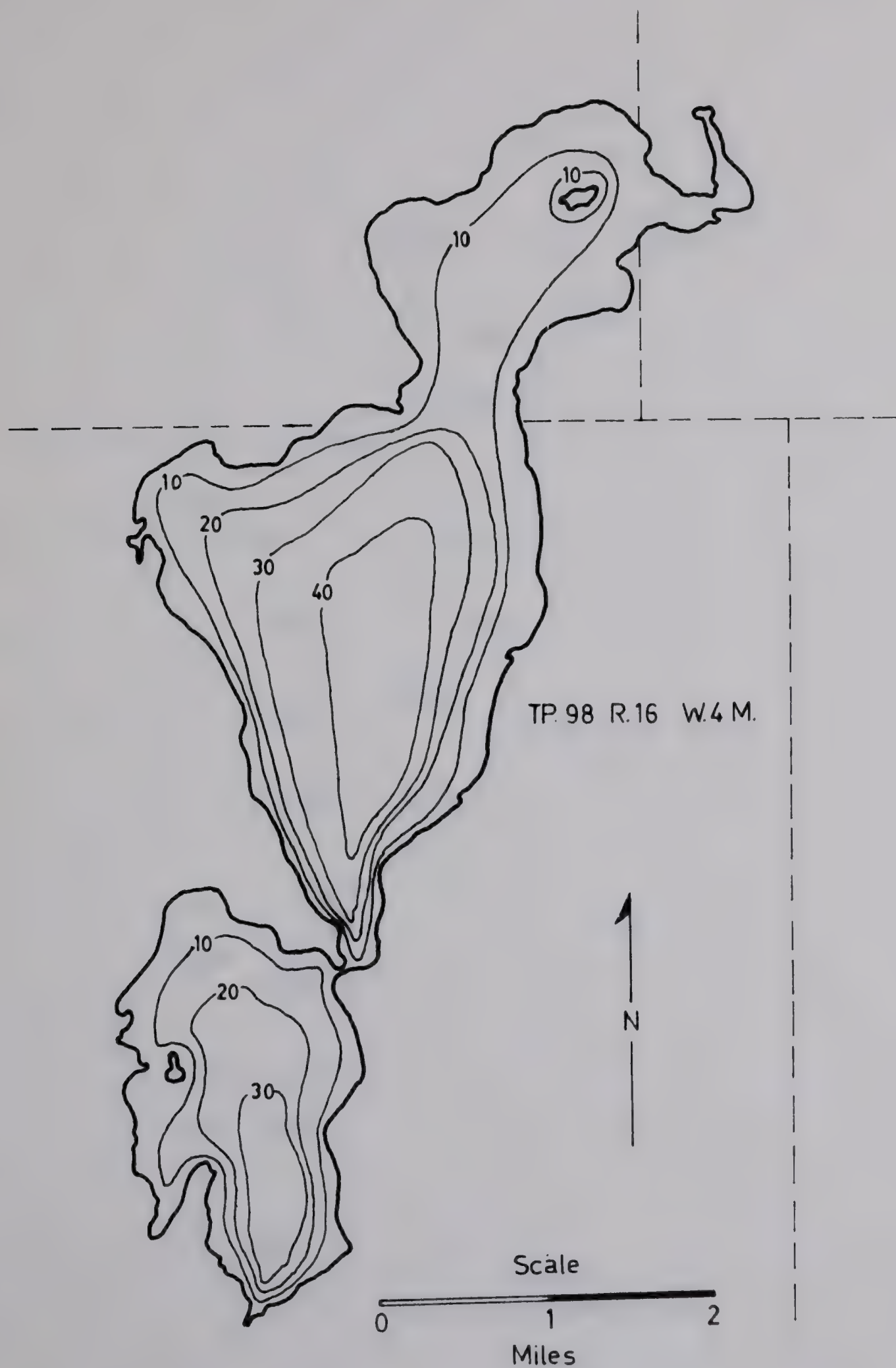




FIGURE 2. Bottom sampling stations on Gardiner Lakes.

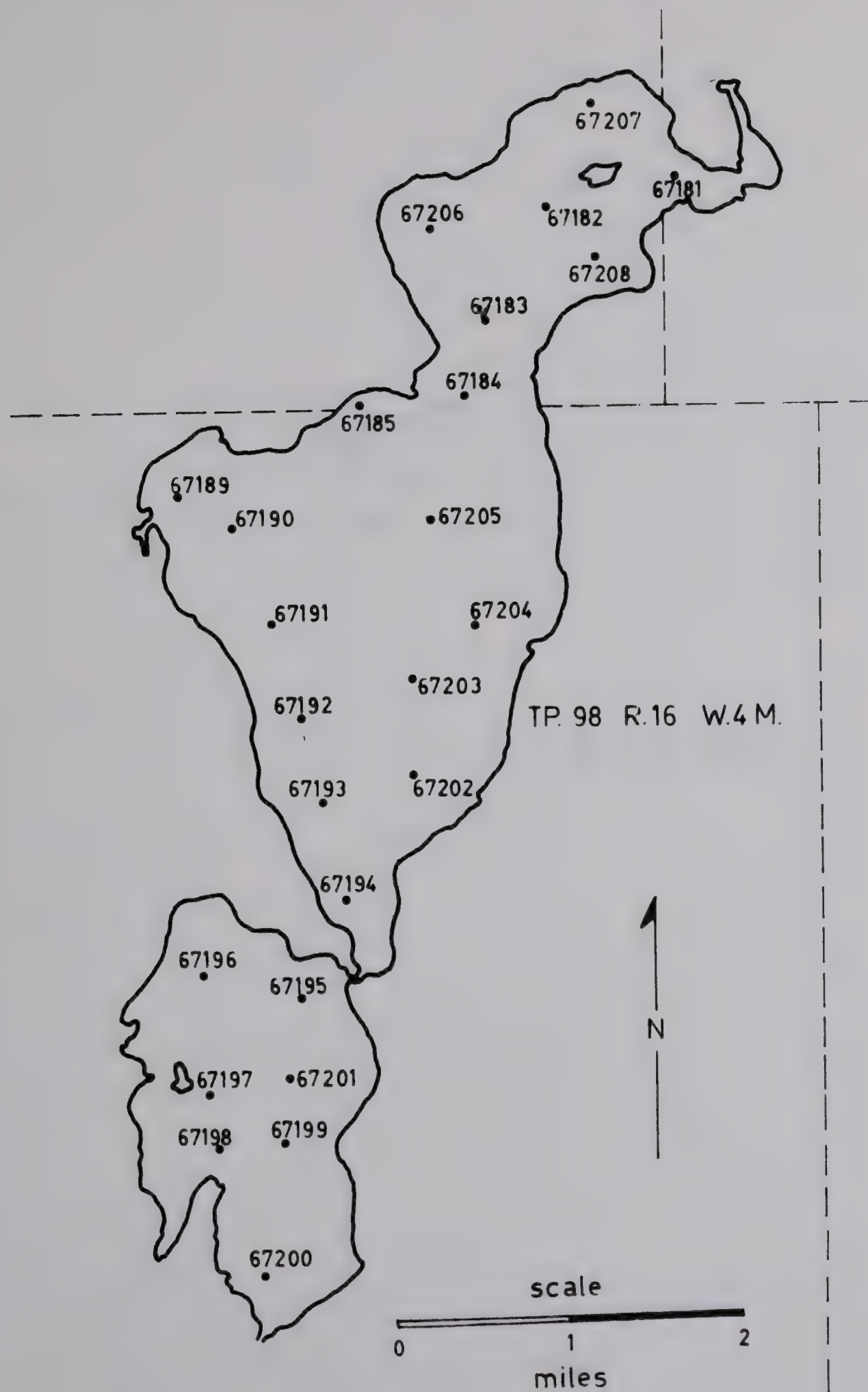






FIGURE 3. Net sets and limnology station on Gardiner Lakes.

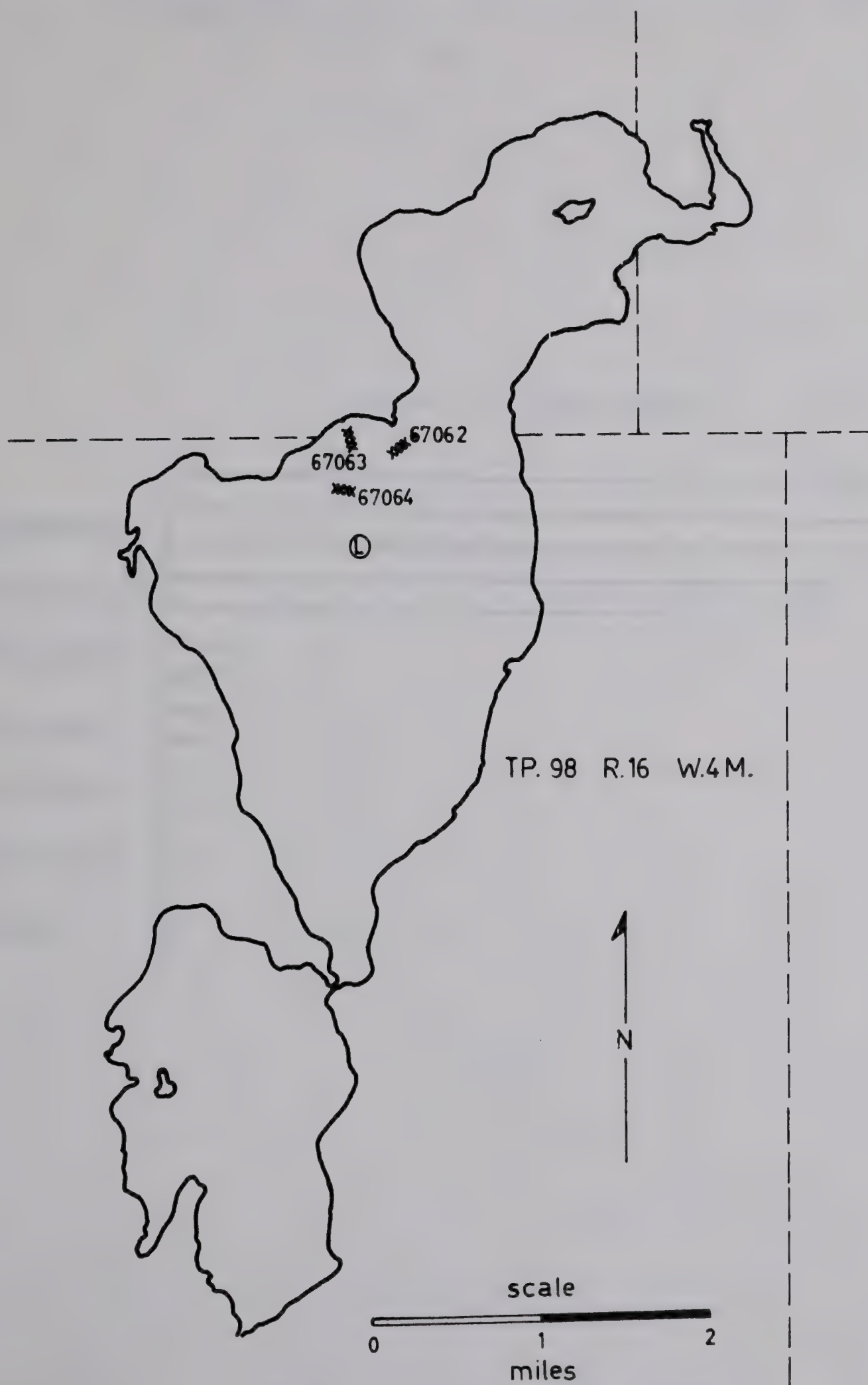




FIGURE 4. Relative abundance of bottom fauna from Gardiner Lakes, August, 1967.

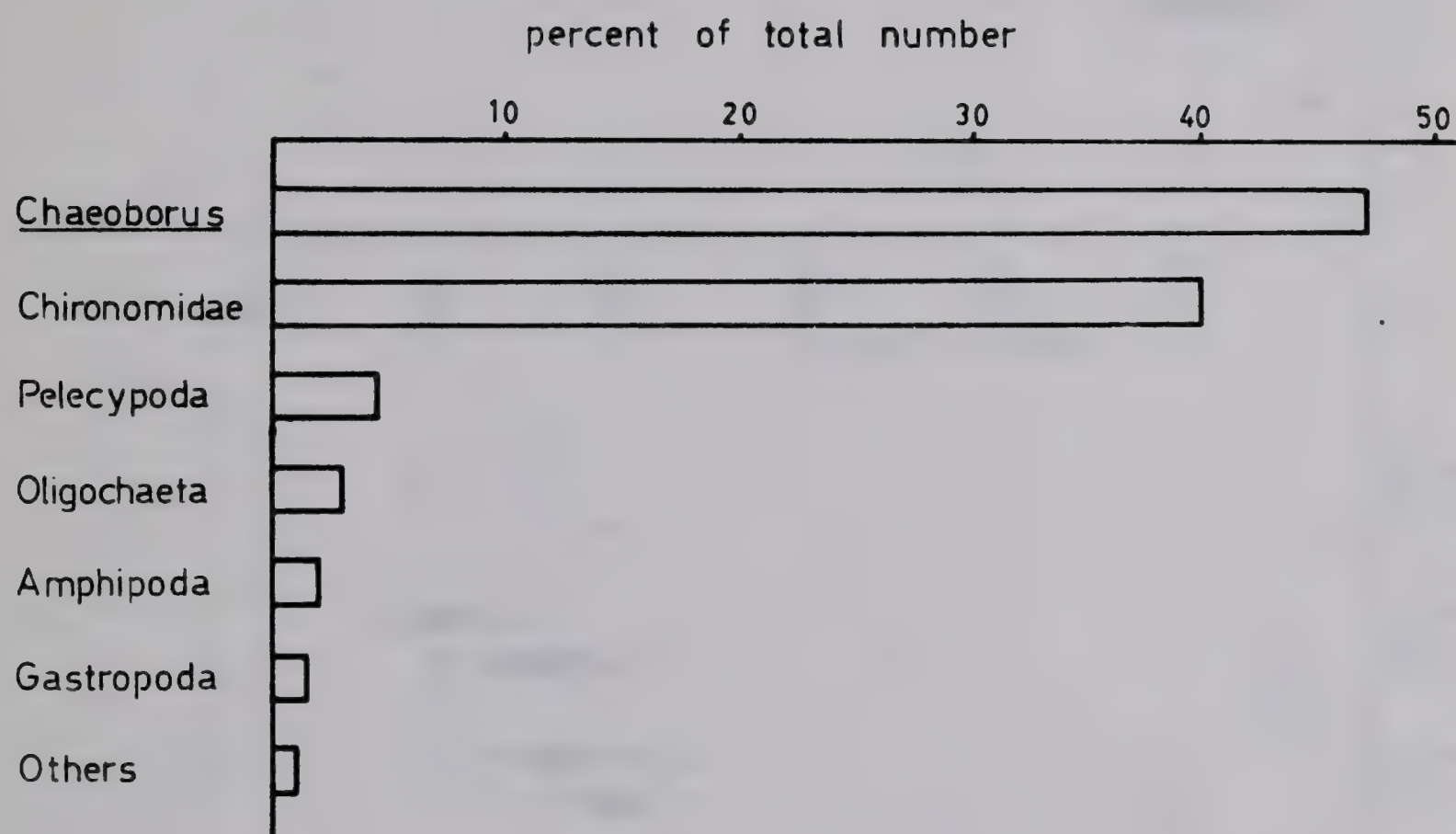






FIGURE 5. Walleye from Gardiner Lakes, August, 1967, showing the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each sample is indicated.

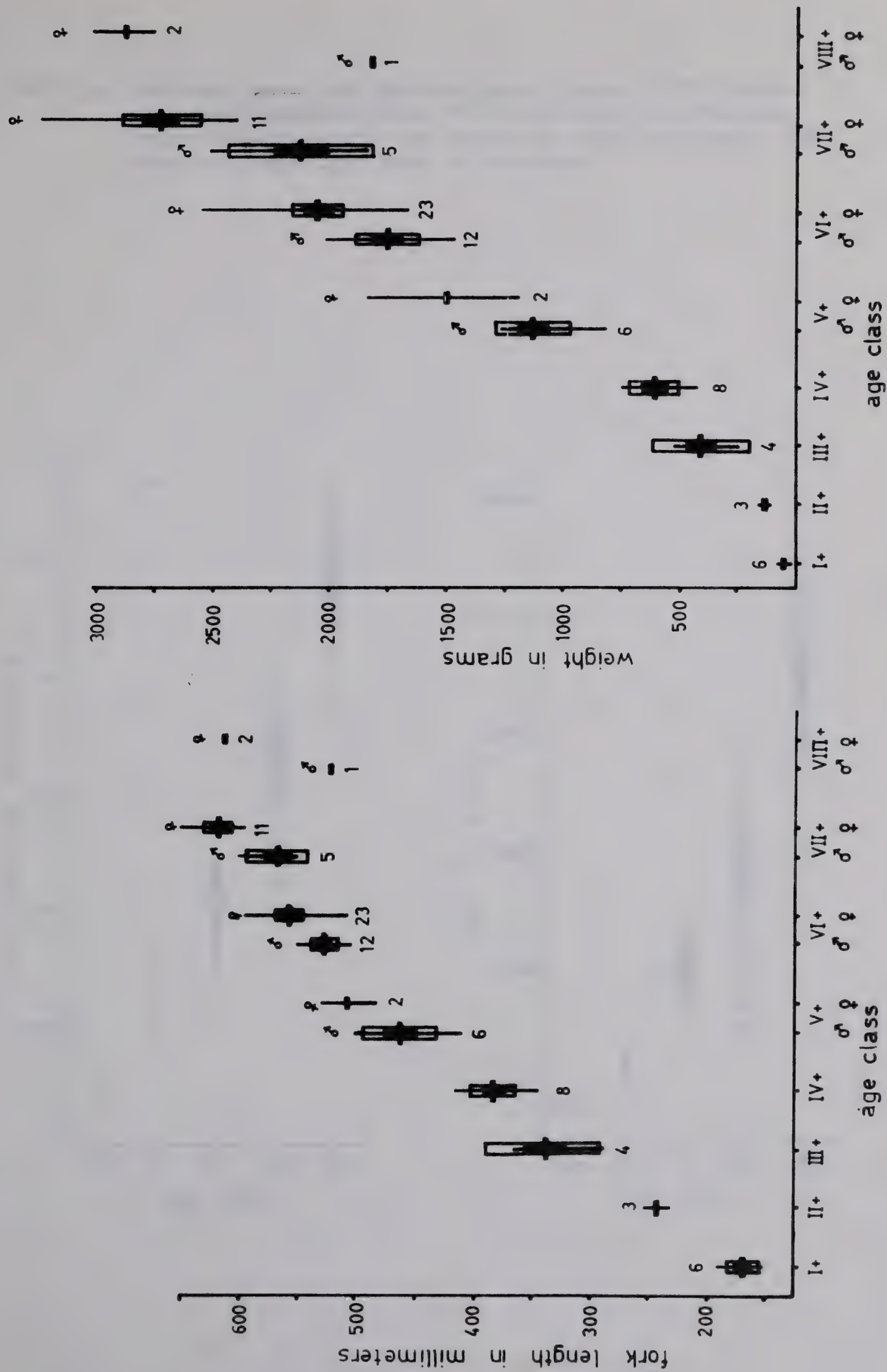




FIGURE 6. Northern pike from Gardiner Lakes, August, 1967 showing the mean, standard error, 95% confidence interval and range in fork length and weight for each age class. The number in each age class is indicated.

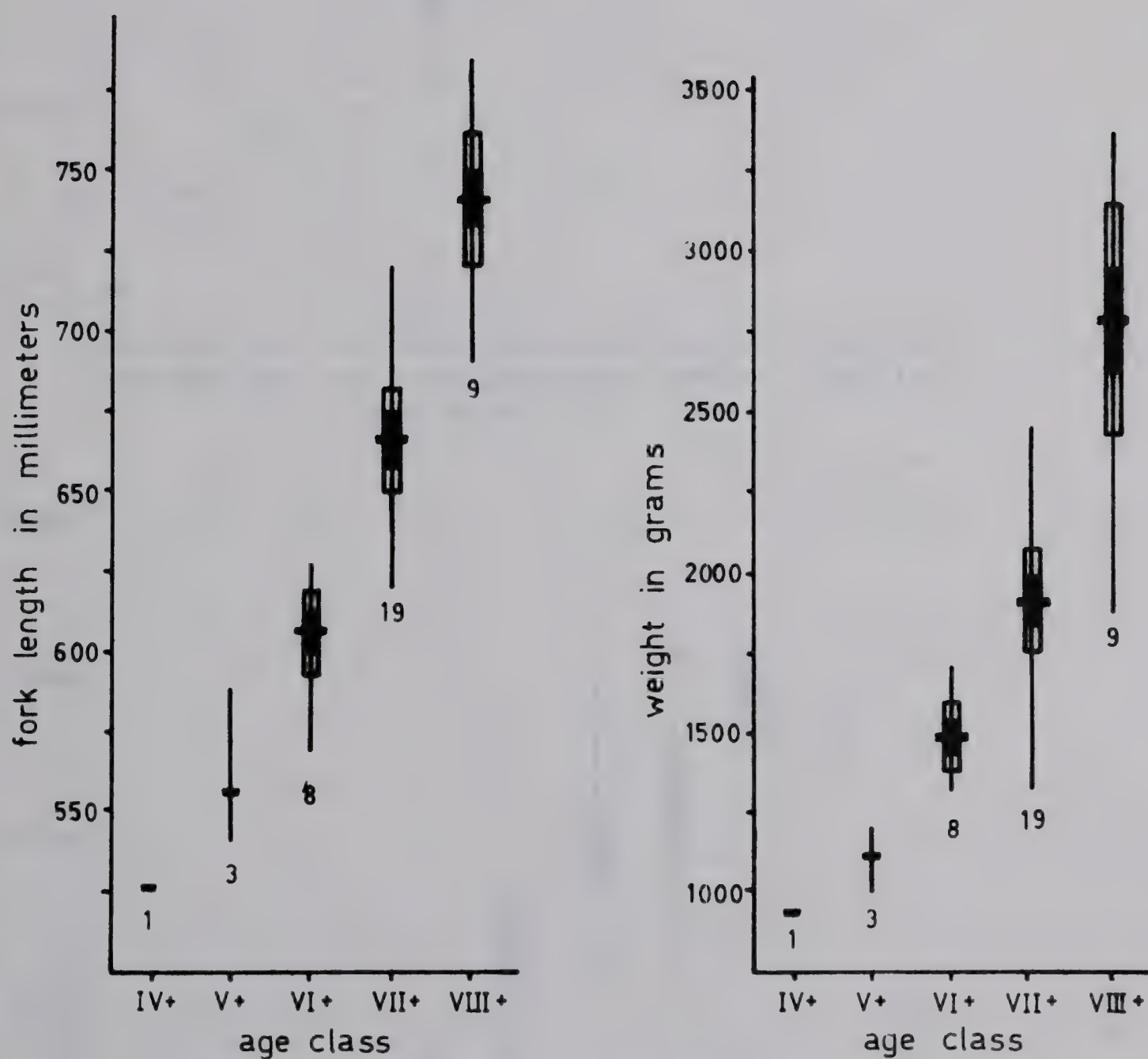
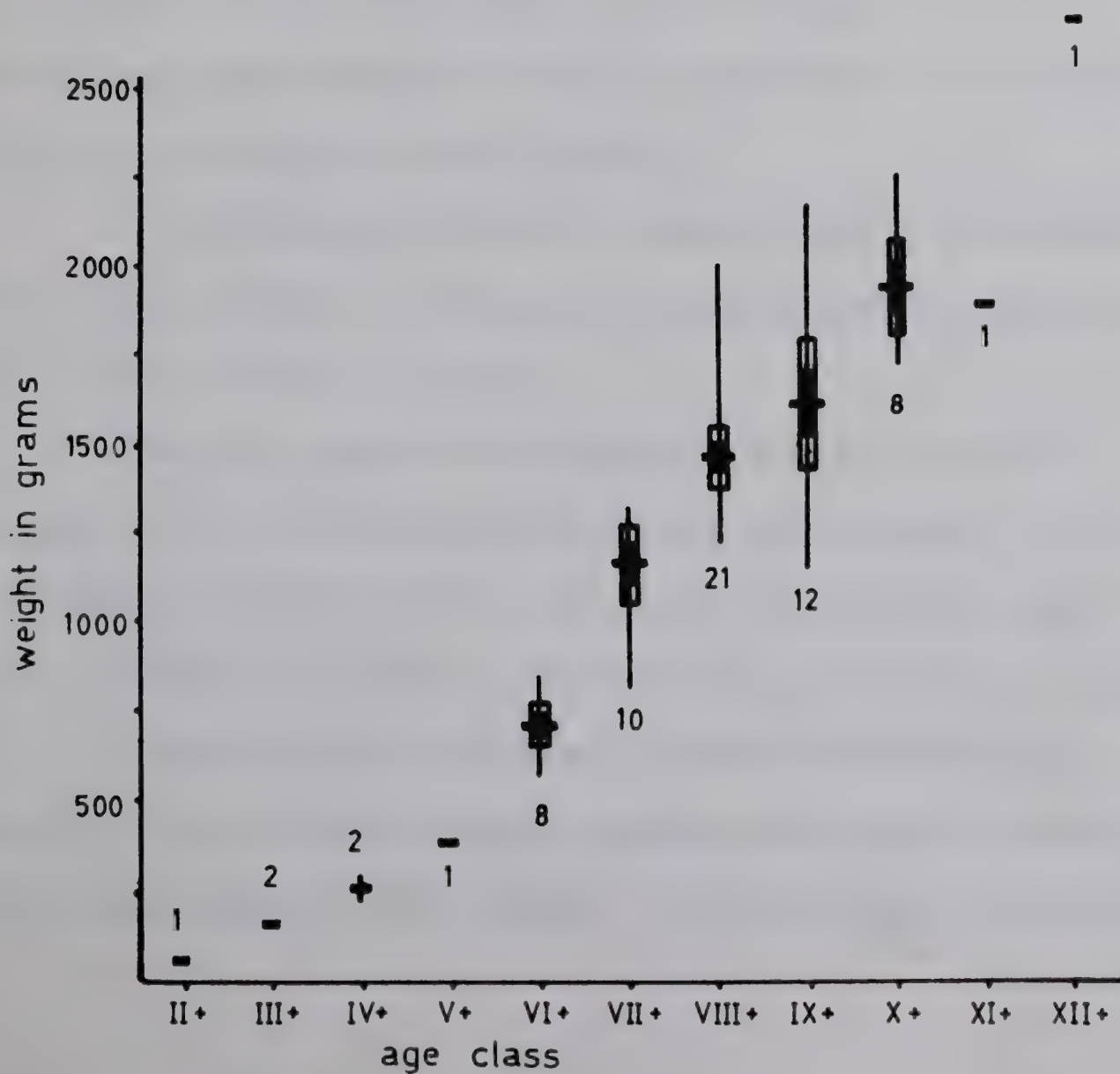
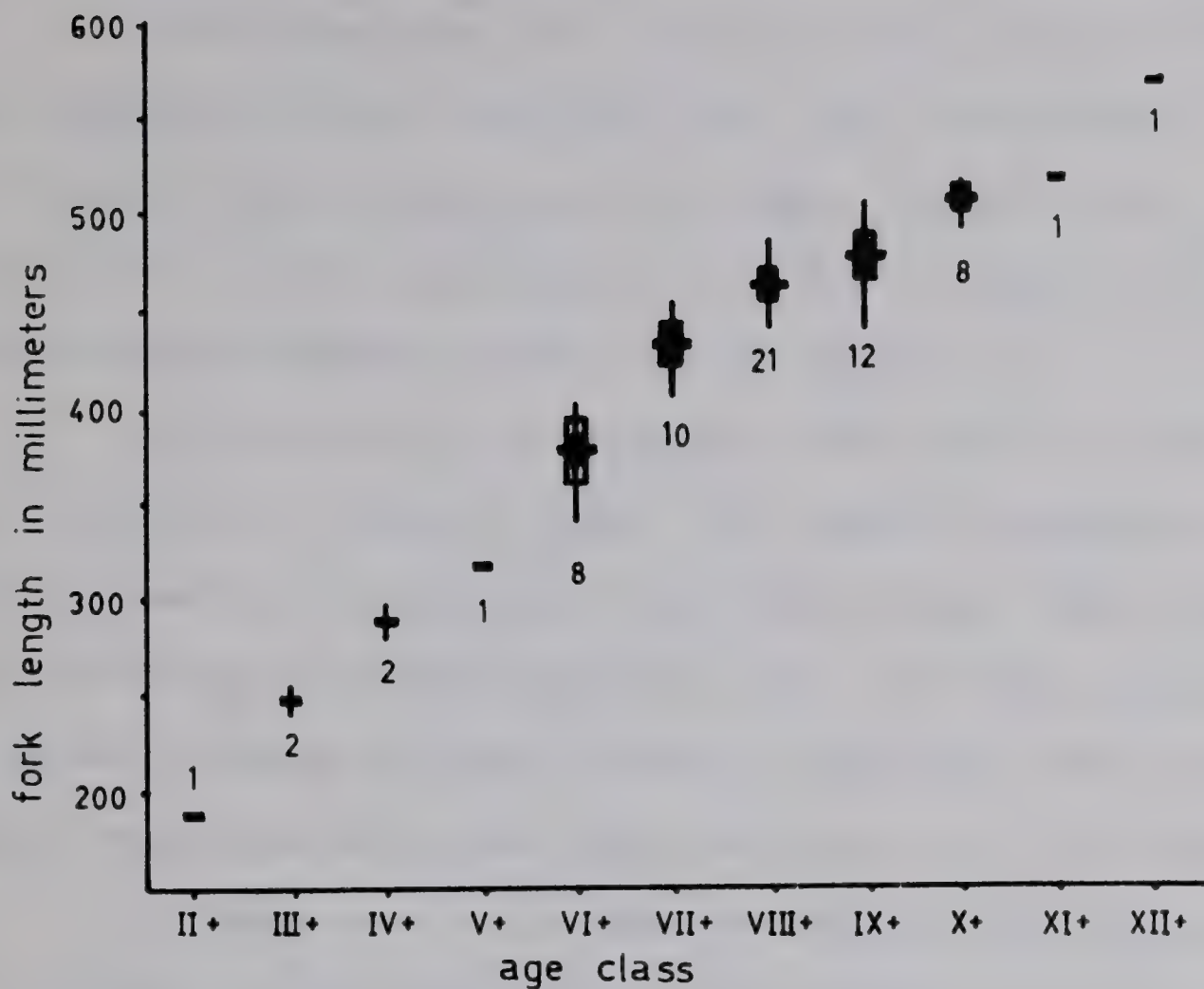






FIGURE 7. Lake whitefish from Gardiner Lakes, August, 1967, showing the mean, standard error, 95% confidence interval and the range in fork length and weight for each age class. The number in each age class is indicated.





UNNAMED STREAM ENTERING GARDINER LAKE

This stream rises about five miles west of Gardiner Lake and flows into the west side of the lake. The lower half mile of stream is very slow and choked with weeds. The stream was examined about  $\frac{3}{4}$  miles upstream from its entry into Gardiner Lake (stream station #67009) on August 25, 1967 (Figure 1).

At the station, the stream had a mean width of 15 feet and a mean depth of about 15 inches. The velocity was moderate and there was a good succession of pools and riffles. Many of the pools were large and deeper than three feet. The bottom consisted of gravel and rubble with sand and muck in the pools. Very little aquatic vegetation was evident except for some algae on the rocks.

The banks were two to three feet high and the bank cover was very good. This stream appeared to be subject to severe flooding and large amounts of deadfall were found in the stream, providing good shade and cover for fish.

The invertebrate fauna was sampled using a square-foot surber sampler (Table I). The bottom fauna appears to be quite poor in both quantity and variety.

Two water samples were taken and analyzed (Table II). The water had a relatively high alkalinity and hardness, the pH was slightly alkaline and the conductivity was relatively high (135 to 136 mmhos/cm @ 18°C). The water was quite brown in color.

A sample of the fish population was collected using rotenone. Slimy sculpins (Cottus cognatus) and young-of-the-year burbot (Lota lota) were very abundant, making up most of the catch at

this time. A few young-of-the-year northern pike (Esox lucius) and white suckers (Catostomus commersoni) were caught, while only one arctic grayling (Thymallus arcticus) was obtained.

This stream has little potential for a sport fishery as further upstream from the station it becomes quite small and downstream it is very sluggish.



TABLE I. Bottom fauna from Unnamed stream entering Gardiner Lake. Three square foot surber samples were taken on August 25, 1967 at stream station #67009. Only the presence (x) or absence (-) of an organism in the sample is noted.

Group	Organism	Sample No.		
		67186	67187	67188
Oligochaeta	<u>Pristina osborni</u>	-	x	x
Megaloptera	<u>Sialis sp.</u>	x	-	-
Trichoptera	<u>Brachycentrus sp.</u>	x	-	-
	<u>Glossosoma sp.</u>	x	-	-
	<u>Agapetus sp.</u>	-	x	x
Diptera	<u>Atherix sp.</u>	x	-	-
Pelecypoda	<u>Sphaerium sp.</u>	-	x	-

TABLE II. Water chemistry, Unnamed stream entering Gardiner Lake. Two water samples were taken on August 25, 1967 at stream station #67009.

Sample No.	67078	67079
Dissolved Oxygen (ppm)	9	9
Total alkalinity (ppm CaCO <sub>3</sub> )	90	90
Calcium hardness (ppm CaCO <sub>3</sub> )	60	60
Total hardness (ppm CaCO <sub>3</sub> )	100	100
pH (Hellige)	7.2	7.2
Conductivity (mmhos/cm @ 18°C)	136	135

### ELLS RIVER

The Ells River drains a large portion of the lakes on the eastern edge of the Birch Mountains, its point of origin being Eaglenest Lake in Township 101, Range 14, West of the 4th Meridian. The Ells River is generally quite swift with steep banks as it flows down the eastern slope of the Birch Mountains. It becomes slow and meandering as it nears the Athabasca River.

The Ells River was examined on August 27, 1967 at a point about three miles upstream from Gardiner Lake (Station #67010). Here the stream had a mean width of about 30 feet and a mean depth of about 3 feet. There was a good succession of pools and riffles in the stream section examined, with many of the pools being large, deep and with good cover.

The bottom consisted of gravel and rubble in the riffle areas with sand and muck in the pools. The aquatic vegetation was fairly dense in some areas of the large pools. The stream banks were heavily overgrown, particularly with willows, and none of the banks were exposed.

The bottom fauna was quite varied and abundant (Table I), as sampled with a square-foot Surber sampler and an aquatic dip net.

A water sample was collected at the station (Table II), which shows the alkalinity and hardness to be relatively high for this area. The pH was alkaline and the conductivity was relatively high (127 mmhos/cm @ 18°C). The water had a slight brown color.

Downstream from the station, the river became quite slow flowing and deeper, with few riffles and aquatic vegetation more abundant.

The stream was treated with rotenone at the station and a sample of the fish population collected. Lake whitefish (Coregonus clupeaformis), trout perch (Percopsis omiscomaycus), northern pike (Esox lucius) and white suckers (Catostomus commersoni) were abundant. Burbot (Lota lota) and walleye (Stizostedion vitreum) were common while arctic grayling (Thymallus arcticus), slimy sculpins (Cottus cognatus) and perch (Perca flavescens) were quite scarce. Many of the northern pike, walleye and lake whitefish were quite large and the two former would provide good sport fishing. Further upstream the grayling are probably more abundant and would provide excellent sport fishing.

At the point examined, the Ells River appears to be quite productive and have some value for a sport fishery. Downstream from Gardiner Lakes, the river would appear to be (from the air) fairly suitable for arctic grayling, and as it approaches the Athabasca River and becomes sluggish, it would probably provide a good warm water sport fishery for walleye and northern pike.



TABLE I. Invertebrate fauna from the Ells River, taken on August 27, 1967 at stream station 67010 with dip nets and surber sampler. Only the presence (x) or absence (-) of an organism in the sample is indicated.

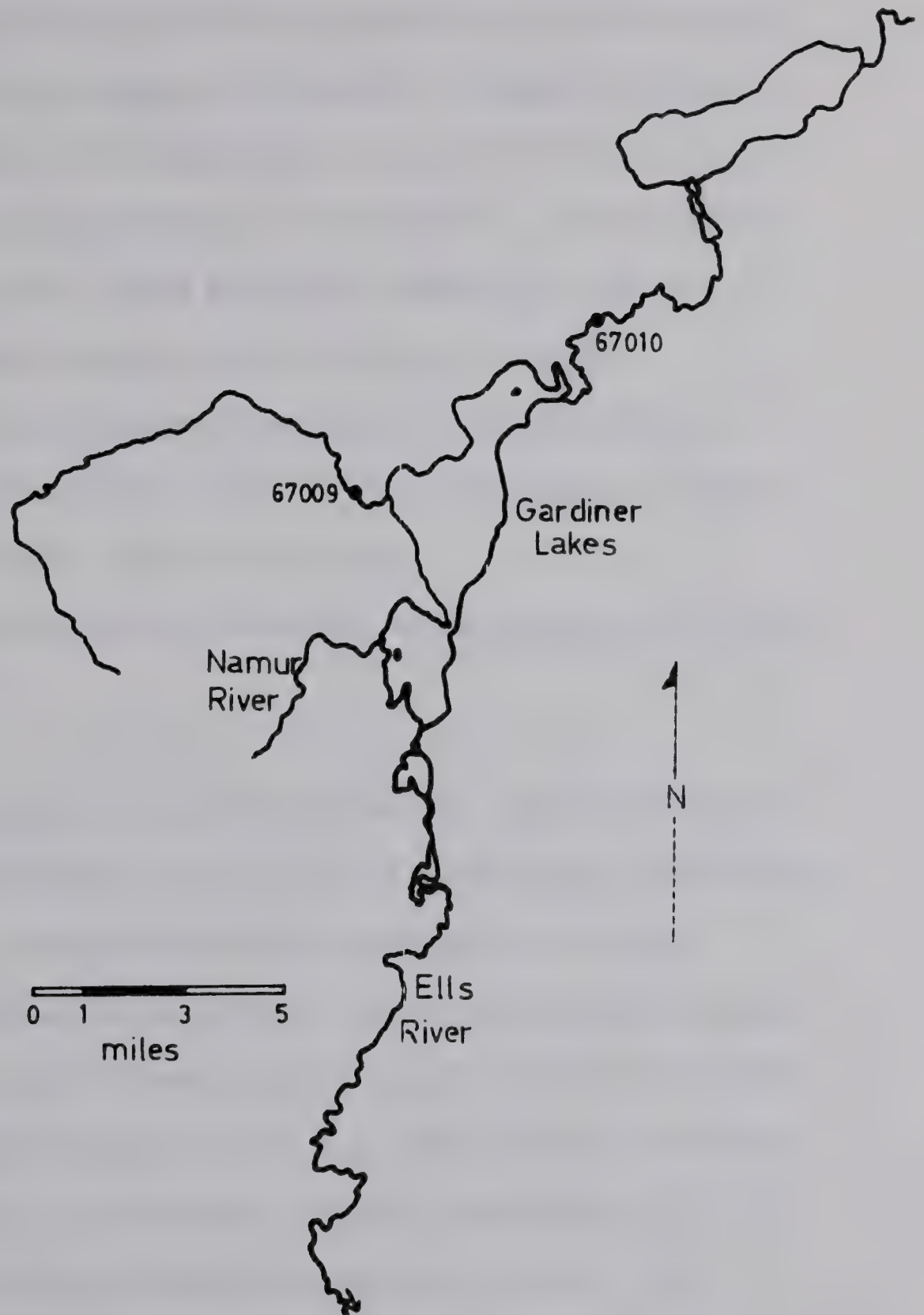
Group	Organism	Sample No.		
		67026	67209	67210
Oligochaeta	Naididae	-	-	-
Plecoptera	<u>Isogenus sp.</u>	-	x	x
	<u>Perlinella drymo</u>	-	x	x
Ephemeroptera	<u>Leptophlebia sp.</u>	x	-	-
	<u>Hexagenia sp.</u>	x	-	-
	<u>Baetis sp.</u>	x	-	-
Trichoptera	<u>Limnephilus sp.</u>	x	-	-
	<u>Hydropsyche sp.</u>	-	x	x
	<u>Brachycentrus sp.</u>	-	x	x
	<u>Glossosoma sp.</u>	-	x	-
Hemiptera	Corixidae	x	-	-
Coleoptera	Elmidae	-	x	-
Diptera	Chironomidae	x	x	-
Gastropoda	<u>Physa sp.</u>	x	-	-
	<u>Valvata sp.</u>	x	-	-

TABLE II. Water chemistry, Ells River. One sample was taken on August 27, 1967 at stream station 67010.

Phenolphthalein alkalinity (ppm $\text{CaCO}_3$ )	0
Total alkalinity (ppm $\text{CaCO}_3$ )	75
Calcium hardness (ppm $\text{CaCO}_3$ )	40
Total hardness (ppm $\text{CaCO}_3$ )	60
pH (Hellige)	7.6 +
Conductivity (mmhos/cm @18°C)	127



Figure 1. Locations of stream stations on the Ells River and a small stream entering Gardiner lakes.





## UNNAMED LAKE (99-16-W4M)

### INTRODUCTION

This lake lies in the Birch Mountains at an altitude of about 2250 feet and is located in Township 99, Range 16, West of the Fourth Meridian, at an approximate latitude of  $57^{\circ} 35' N$ . It is about 100 air miles northwest of Fort McMurray, Alberta and is accessible only by float plane during the summer, but may be reached by dogteam or tracked vehicle during the winter.

The lake was surveyed from August 28 to September 4, 1967. Men and equipment were flown in by a light plane on floats and survey methods were limited accordingly.

There is no record of this lake being commercially fished.

### MORPHOMETRY

This lake has an area (determined by planimeter from one inch to one mile planimetric maps) of 6.09 square miles (3898 acres). The length of the shoreline (including the shoreline of nine islands) was determined to be 23 miles, giving a shoreline development factor (comparison of actual shoreline to the shortest length that would enclose the same area) of 2.6. This shoreline development is indicative of an extensive littoral zone (Table I).

Depths were determined using an echo sounder. The soundings were used to construct a contour map and the volume estimated from this is approximately 66,000 acre-feet, giving a mean depth of 17 feet, while the maximum depth found was 49 feet.

Most of the lake is quite shallow, with 38% being shallower than 10 feet, and only 20% deeper than 30 feet. Most of the lake is in the euphotic zone.

The maximum length of the lake is 5.5 miles in a northwest-southwest direction. The maximum effective length however, is only three miles, while the maximum width is 2.2 miles and the maximum effective width is two miles. The major portion of this lake is open to the action of the wind and since this portion is the only portion with any notable depth, the wind should mix the lake waters quite thoroughly.

The morphometry of this lake suggests a relatively eutrophic condition.

#### PHYSICAL AND CHEMICAL FEATURES

A limnology station was established on September 4, 1967. The depth at the station was 42 feet. There was no evidence of thermal stratification in the lake at this time and it is probable that there is no stable thermal stratification in this lake during the summer because the only "deep" portion of the lake is well exposed to wind action (Table III). Dissolved oxygen values and pH were fairly consistent from top to bottom indicating the lake was thoroughly mixed.

The secchi disc visibility was seven feet, the transparency being reduced by an extensive plankton "bloom" in progress at the time. The water had a slight brown color but this would not reduce its transparency to any great extent.

Four water samples were taken at the limnology station on



September 4, 1967 (Table IV). The water had a total alkalinity of 60 p.p.m. as  $\text{CaCO}_3$  while the calcium hardness was only 30 p.p.m. and the total hardness was 40 p.p.m. as  $\text{CaCO}_3$ . The pH of the water was slightly alkaline, being 7.2 from top to bottom and the conductivity (standardized to  $18^\circ\text{C}$ ) ranged from 81 to 85  $\mu\text{mhos/cm}$ . The amount of dissolved nutrients is probably quite low in this lake and may limit its productivity.

#### BOTTOM FAUNA

Fourteen bottom samples were collected with a six-inch-square Ekman dredge at different locations on September 4, 1967 (Figure 2). The samples were washed through a screen bottomed bucket (25 meshes per inch) and all living organisms preserved (Table II).

From the bottom samples, the lake bottom appears to consist of organic muck, well decomposed, with some undecomposed organic detritus. The shoreline is of sand or gravel except at the north end where most of the shore was of mud.

The bottom samples yielded an average of 5699 organisms per square meter, with a mean displaced volume of 60.28 c.c. per square meter. The most abundant group of organisms were the chironomids, followed by the oligochaetes, amphipods and pelecypods (in that order). All other groups were insignificant in number and volume (Figure 4).

The bottom fauna is quite rich and reflects the eutrophic nature of the lake.

## PLANKTON

Vertical plankton hauls were taken with a Wisconsin type plankton net (mouth diameter of 20 cm.) at the limnology station on September 4, 1967. An extensive plankton "bloom" was in progress at the time.

The phytoplankton was dominated by blue-green algae, particularly Microcystis and Coelosphaerium. Anabaena and Lyngbea were also present in good abundance. The predominance of this group of algae is typical of fall "blooms" (Table V).

The diatoms, represented by Stephanodiscus and Melosira, were present in fair numbers, as were the dinoflagellates, represented by the genus Ceratium. A total absence of green algae in the sample may be noted.

The zooplankton was dominated by copepods, which consisted largely of adults and very few nauplii. Cladocera were also present and rotifers were abundant.

## FISH FAUNA

Nets were lifted on August 29, 1967 and September 3, 1967. Nets ranging in size from 1½ to 5½ inches (stretched measure) were set. All were 100 yards in length except the 1½ inch mesh, which was 50 yards in length.

Fish caught included lake whitefish (Coregonus clupeaformis), walleye (Stizostedion vitreum), northern pike (Esox lucius), tullibee (Coregonus artedii), perch (Perca flavescens), white suckers (Catostomus commersoni) and burbot (Lota lota) (Table VI).



The most abundant species in the lake would appear to be tullibee, large numbers being taken in the  $2\frac{1}{2}$  and  $3\frac{1}{2}$  inch mesh nets. Relatively few whitefish were caught, these fish being taken in  $3\frac{1}{2}$ ,  $4\frac{1}{2}$  and  $5\frac{1}{2}$  inch mesh nets. Walleye were quite numerous in the sample, being caught in all mesh sizes. Other species were not abundant although there is probably a substantial number of northern pike in the lake.

### Walleye

Thirty-five walleye were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination.

These fish appear to be relatively fast growing, the oldest fish examined being seven years of age (Table VII, Figure 5). The dominant age class in the sample was five. Most males probably spawn in their fifth year while the females do not spawn until their sixth year. The spawning habitat for this species is quite adequate.

The large amount of forage fish available is advantageous to this species and would help provide a good sport fishery.

### Northern pike

Thirteen northern pike were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination.

These fish ranged from four to eleven years in age and ranged in size from 570 to 6000 grams (Table VIII). They probably spawn first during their fourth or fifth year. The spawning

habitat for this species is quite adequate and the large population of forage fish should help maintain a moderate sport fishery for this species.

#### Lake whitefish

Eleven lake whitefish were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination.

These fish do not appear to be too plentiful nor do they exhibit a fast growth rate (Table IX). They probably spawn first during their seventh or eighth year and there may be some restriction of spawning habitat as the areas of sand bottom do not extend far into the lake. Ten whitefish were examined for plerocercoids of Triaenophorus crassus. All were infested, with a total of 38 cysts. Their total weight was 21.81 pounds giving a rate of infestation of 174 cysts per 100 pounds of fish. This is too high for these fish to be of much commercial value.

#### Tullibee

Thirty-one tullibee were examined, the fork length, weight, sex and maturity of each were recorded. Only the two age classes, six and seven, were present in the sample. They ranged in size from 270 to 420 grams and all were mature (Table X).

It would appear that a large number of small, slow growing tullibee are present in the lake. These would provide good forage for walleye and northern pike.

This species may encounter some restriction of spawning



habitat, as with the lake whitefish, although this is doubtful.

The species is of little commercial value, but has a high value in maintaining a sport fishery.

#### White suckers

Three white suckers were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination. These fish were three and four years of age and are fairly fast growing (Table XI). They probably first spawn during their fourth or fifth year, although there is probably not a significant population of this species in the lake.

#### Perch

Seven perch were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination. They ranged in age from three to six years, were very slow growing and ranged in size from 30 to 170 grams (Table XII). They probably spawn first at the beginning of their fourth or fifth years. The population of perch in this lake appeared to be quite insignificant.

#### DISCUSSION AND CONCLUSIONS

Using the morpho-edaphic index of Ryder (1965) a total annual production of 4.5 pounds per acre is obtained. This is probably a little low and an annual production of about 5 pounds per acre or about 18,500 pounds in total is postulated. About 6,000 pounds could be expected to be in the form of sport fish (walleye and northern pike). The remainder would be tullibee and

lake whitefish. These latter species are of little value commercially. Only the walleye have much value as a commercial species and could be utilized for this purpose until the demand for walleye as a sport fish became evident in this area.

TABLE I. Morphometry of Unnamed Lake (99-16-W4M).

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LOCATION: Tp. 99 - R. 16 - W4M

AREA: 6.09 mi.<sup>2</sup> (3898 a.)

VOLUME: 66,000 acre feet

SHORELINE: 23 miles

SHORELINE DEVELOPMENT FACTOR: 2.6

MAXIMUM LENGTH: 5.5 miles

MAXIMUM EFFECTIVE LENGTH: 3.0 miles

MAXIMUM WIDTH: 2.2 miles

MAXIMUM EFFECTIVE WIDTH: 2.0 miles

MEAN WIDTH: 1.1 miles

MAXIMUM DEPTH: 49 feet

MEAN DEPTH: 17 feet

DEPTH DISTRIBUTION:

Surface Area:	6.09 mi <sup>2</sup>	(3898 a.)	= 100% surface area
10 feet plus:	3.79 mi <sup>2</sup>	(2426 a.)	= 62% surface area
20 feet plus:	1.97 mi <sup>2</sup>	(1261 a.)	= 32% surface area
30 feet plus:	1.19 mi <sup>2</sup>	(762 a.)	= 20% surface area
40 feet plus:	0.71 mi <sup>2</sup>	(454 a.)	= 12% surface area

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TABLE II. Bottom fauna from Unnamed Lake (99-16-W4M). September 4, 1967.

Sample Number	Depth (feet)	Substrate	Ephemeroptera	Chironomidae	Oligochaeta	Amphipoda	Pelecypoda	Gastropoda	Others	Total Number	Displaced Volume (c.c.)
67216	8	Muck Detritus	-	18	-	40	10	-	4	72	0.85
67211	9	Muck	-	10	-	32	15	-	-	57	0.55
67212	9	Muck	-	14	-	28	17	1	-	60	0.50
67213	10	Muck	1	18	3	20	20	-	-	62	1.05
67214	10	Muck	-	13	2	54	20	-	2	91	0.90
67215	10	Muck	-	10	70	11	16	-	-	107	0.65
67222	15	Muck	-	41	3	1	5	-	4	54	0.55
67223	27	Muck	-	145	10	-	8	-	-	163	3.50
67224	27	Muck	-	93	60	-	-	-	-	153	1.60
67217	33	Muck	-	72	3	-	4	-	-	79	1.05
67218	39	Muck	-	120	5	-	1	2	2	128	1.55
67220	42	Muck	-	176	55	-	7	-	-	238	2.20
67221	45	Muck	-	270	60	-	5	-	-	335	2.70
Totals			1	1235	286	186	131	4	10	1853	19.60



TABLE III. Physical and chemical observations, Unnamed Lake  
(99-16-W4M), September 4, 1967.

Depth (feet)	Temperature (°C)	Dissolved Oxygen		Conductivity (mmhos/cm @18°C)	pH
		ppm	% Saturation		
0	15	7	70	85	7.2
5	15.5				
10	15.5	7	70	82	7.2
15	15.5				
20	15.5	7	70	81	7.2
25	15.5				
30	15				
35	15				
40	14.5	6	60	81	7.2
42	13.5				

TABLE IV. Water chemistry of Unnamed Lake (99-16-W4M). Four samples were taken at the limnology station on September 4, 1967.

Sample Number	67085	67086	67087	67088
Depth (feet)	0	10	20	40
Temperature ( $^{\circ}\text{C}$ )	15	15.5	15.5	14.5
Dissolved oxygen (ppm)	7	7	7	6
Phenolphthalein alkalinity (ppm $\text{CaCO}_3$ )	0	0	0	0
Total alkalinity (ppm $\text{CaCO}_3$ )	60	60	60	60
Calcium hardness (ppm $\text{CaCO}_3$ )	30	30	30	30
Total hardness (ppm $\text{CaCO}_3$ )	45	40	40	40
pH (Hellige)	7.2	7.2	7.2	7.2
Conductivity (mmhos/cm @ $18^{\circ}\text{C}$ )	85	82	81	81

TABLE V. Plankton from Unnamed Lake (99-16-W4M). September 4, 1967.

PHYTOPLANKTON

<u>GROUP</u>	<u>ORGANISM</u>	<u>RELATIVE ABUNDANCE</u>
Cyanophyta	<u>Microcystis</u>	Very abundant
	<u>Coelosphaerium</u>	Very abundant
	<u>Anabaena</u>	Abundant
	<u>Lyngbya</u>	Common
Chrysophyta	<u>Melosira</u>	Common
	<u>Stephanodiscus</u>	Very abundant
Pyrrhophyta	<u>Ceratium</u>	Abundant

ZOOPLANKTON

<u>GROUP</u>		<u>RELATIVE ABUNDANCE</u>
Copepoda	Adults	Abundant
	Nauplii	Rare
Cladocera		Common
Rotifera		Very abundant

TABLE VI. Test net results, Unnamed Lake (99-16-W4M). August 29 and September 3, 1967.

Net Set No.	Duration of Set (hours)	Depth Fished (feet)	Mesh Size (ins)	Lake Whitefish	Walleye	Northern Pike	Tullibee	Perch	Others	Totals
67065	4	30	1½	-	2	-	-	2	-	4
67065	4	25	2½	-	2	-	16	-	-	18
67065	4	20	3½	-	6	-	-	-	1	7
67066	4	30	4½	-	7	-	-	-	-	7
67066	4	30	5½	1	1	-	-	-	-	2
67067	12	25	2½	-	20	13	131	6	3	173
67067	12	25	3½	15	35	5	142	-	11	208
67068	15	40	4½	14	42	-	2	-	2	59
67068	15	40	5½	18	14	-	2	-	1	35
Totals				48	129	18	293	8	17	513



TABLE VII. Length, weight and maturity of walleye from Unnamed Lake (99-16-W4M). Thirty-three fish were examined. (Figure 5).

Age Class	Sex	n	No. Mature	Fork Length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
I+	-	1	0	190			70		
IV+	both	7	2	393	$\pm 4.9$	373-410	709	$\pm 29.1$	590-800
V+	♀	8	8	439	$\pm 10.2$	410-485	1050	$\pm 93.8$	840-1510
V+	♀	10	1	434	$\pm 3.8$	420-460	994	$\pm 32.7$	840-1170
VI+	both	5	5	513	$\pm 27.4$	431-573	1750	$\pm 269.0$	900-2430
VII+	both	2	2	560			2225		2120-2330

TABLE VIII. Length, weight and maturity of northern pike from Unnamed Lake (99-16-W4M). Thirteen fish were examined.

Age Class	Number	No. of Females	No. Mature	Fork Length (mm)		Weight (gms)	
				Mean	Range	Mean	Range
IV+	3	1	2	498	464-524	830	570-1000
V+	2	0	2	558	545-572	1220	1190-1250
VI+	4	3	4	656	631-680	1910	1750-2060
VII+	1	1	1	750		2660	
VIII+	1	1	1	750		3350	
IX+	1	1	1	815		4140	
XI+	1	1	1	925		6000	

TABLE IX. Length, weight and maturity of lake whitefish from Unnamed Lake (99-16-W4M). Eleven fish were examined.

Age Class	Number	No. of Females	Number Mature	Fork Length (mm)		Weight (gms)	
				Mean	Range	Mean	Range
VI+	1	0	0	381		660	
VIII+	4	1	4	392	370-402	842	700-950
IX+	3	0	3	421	416-430	1040	980-1100
X+	3	2	3	451	440-473	1247	1180-1320

TABLE X. Length and weight of tullibee from Unnamed Lake (99-16-W4M). Thirty-one fish were examined. All were mature (Figure 6).

Age Class	n	No. of Females	Fork Length (mm)			Weight (gms)		
			$\bar{x}$	$S\bar{x}$	Range	$\bar{x}$	$S\bar{x}$	Range
VI+	18	7	281	$\pm 1.5$	270-293	312	$\pm 7.4$	270-380
VII+	13	8	295	$\pm 2.2$	282-308	357	$\pm 10.8$	270-420

TABLE XI. Length, weight and maturity of white suckers from Unnamed Lake (99-16-W4M). Three fish were examined.

Age Class	Number	Number of Females	Number Mature	Fork Length (mm)		Weight (gms)	
				Mean	Range	Mean	Range
III+	2	1	0	276	271-280	295	270-320
IV+	1	0	1	316		500	

TABLE XII. Length, weight and maturity of perch from Unnamed Lake (99-16-W4M). Seven fish were examined.

Age Class	Number	Number of Females	Number Mature	Fork Length (mm)		Weight (gms)	
				Mean	Range	Mean	Range
III+	1	-	-	122		30	
IV+	1	0	1	172		80	
V+	2	1	2	199	187-211	120	100-140
VI+	3	3	3	216	210-227	137	120-170





Figure 1. Contours of Unnamed Lake (99-16-W. 4th M.). Contour intervals of ten feet.





Figure 2. Bottom sampling stations on Unnamed Lake  
(99-16-W. 4th M.).

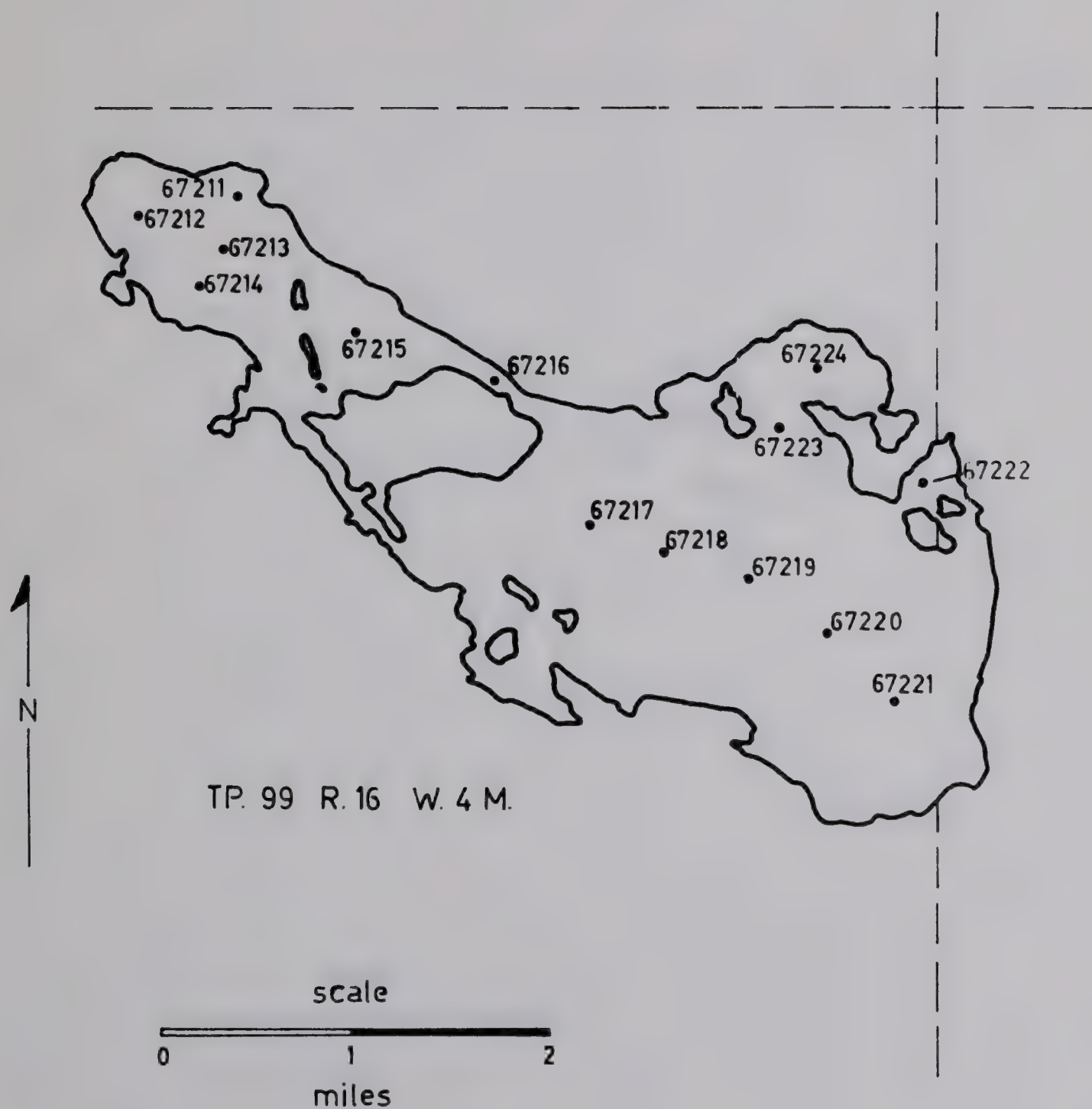






Figure 3. Locations of net sets and limnology station on Unnamed Lake (99-16-W. 4th M.).

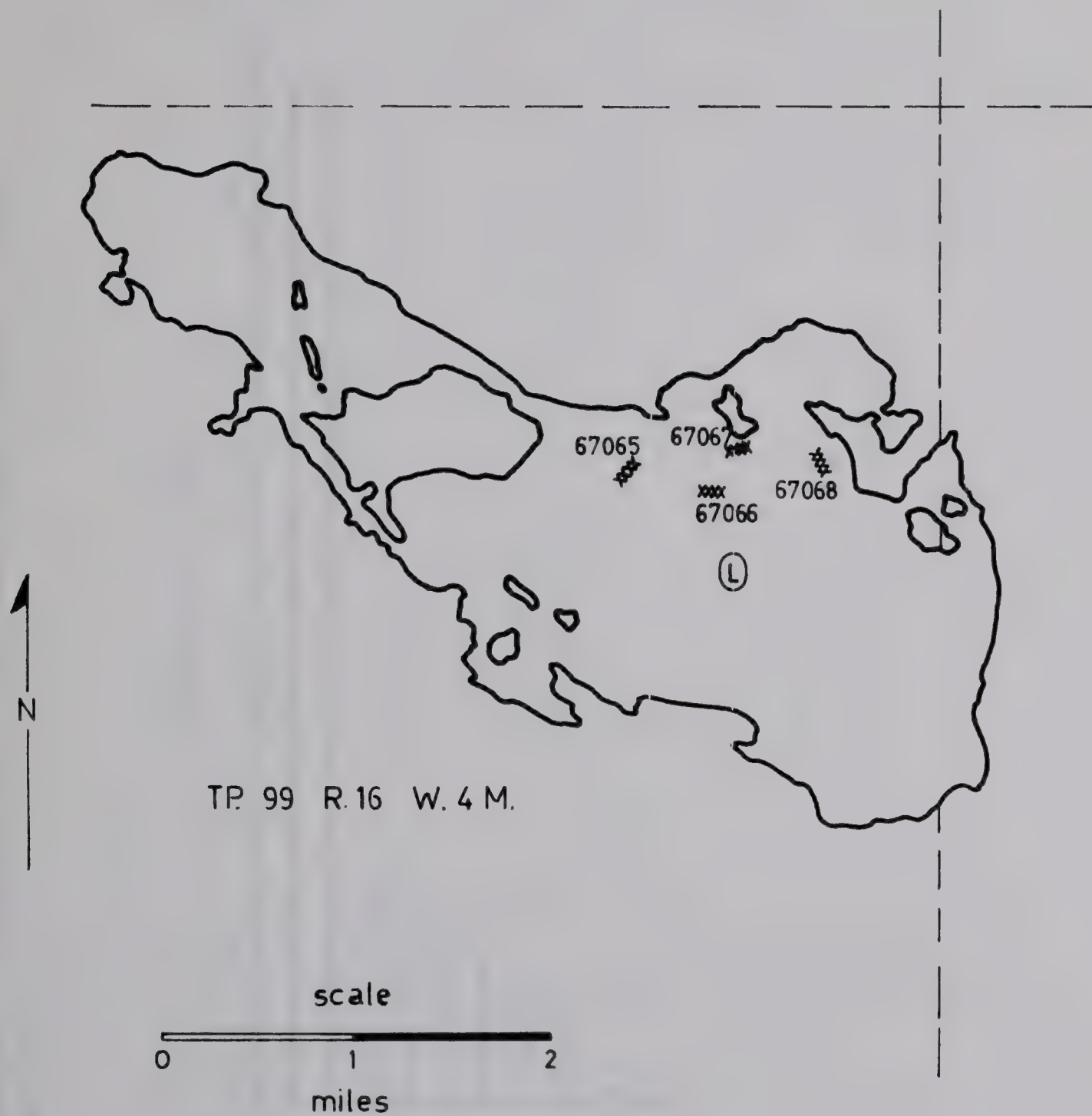




Figure 4. Composition of bottom fauna from Unnamed Lake (99-16-W. 4th M.), August, 1967.

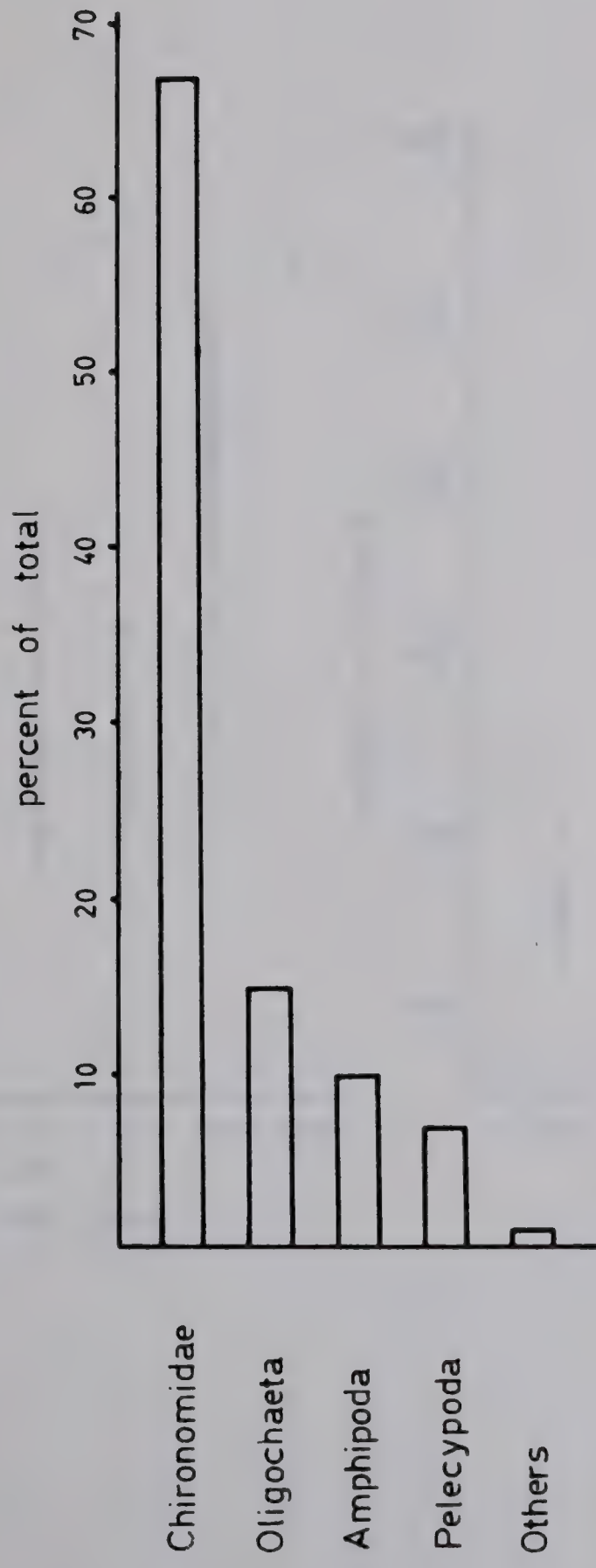
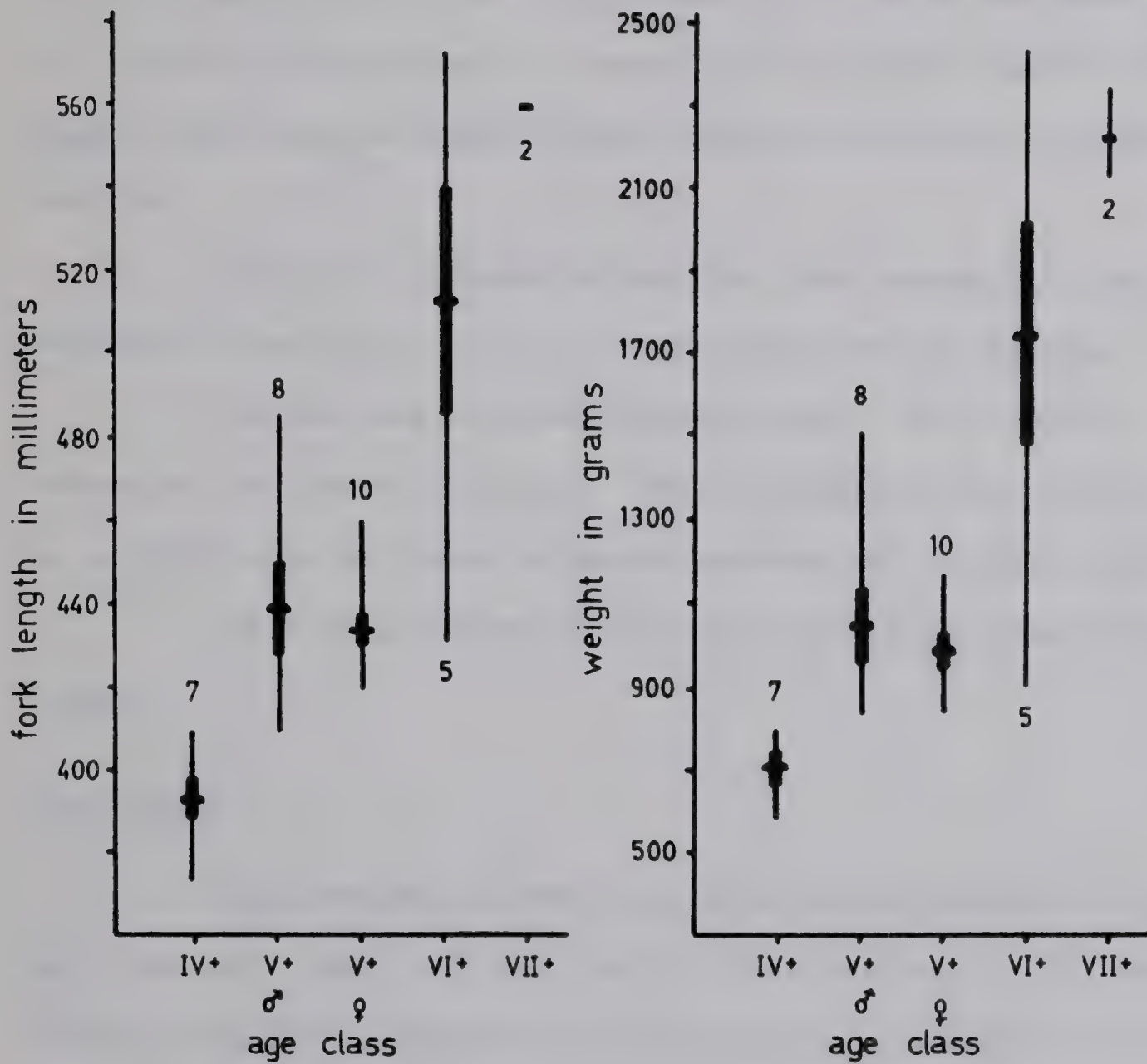






Figure 5. Walleye from Unnamed Lake (99-16-W. 4th M.), September 1967. The figures show the mean, standard error and range in fork length and weight for each age class. The number in each age class is indicated.





## UNNAMED LAKE (100-15-W4M)

### INTRODUCTION

This lake lies in the Birch Mountains at an altitude of approximately 2250 feet. It has no official name and is located in Township 100, Range 15, West of the Fourth Meridian, at a latitude of approximately  $57^{\circ} 40'N$ . It is about 110 air miles northwest of Ft. McMurray, Alberta and is accessible only by float plane in the summer, but could be reached during winter by dog team or tracked vehicle.

The lake is drained by the Ells River system into the Athabasca River and is part of the MacKenzie Drainage System.

The lake was surveyed from September 4 to 9, 1967 to determine its fishery potential. Men and equipment were flown in by a light plane on floats and survey methods were limited accordingly.

There is no record of this lake having been commercially fished.

### MORPHOMETRY

This lake has an area (as determined by planimeter on maps at a scale of 1 inch to 1 mile) of 5.39 square miles or 3450 acres. It has a shoreline length of 12.5 miles, giving a shoreline development factor (ratio of actual shoreline to the shortest length that would enclose the same area) of 1.5. This indicates that the shoreline is quite regular.

Depths were determined with an echo sounder and a contour map was constructed from the soundings obtained. The volume (estimated from the contour map) is approximately 178,000 acre feet.

The maximum length of the lake (in a west southwest to east northeast direction) is 5.1 miles, and the maximum width is 1.5 miles while the mean width is 1.1 miles. This allows good wind action on the lake.

The morphometry of this lake is indicative of a fair degree of oligotrophy.

#### PHYSICAL AND CHEMICAL FEATURES

A limnology station was established on September 9, 1967, the depth at the station being 200 feet. Thermal stratification was quite evident at the time of the survey, with the thermocline being between 40 and 50 feet. Below the thermocline, the temperature decreased to  $4.5^{\circ}\text{C}$ . at 170 feet and stayed at that temperature to the bottom (Table III, Figure 5).

The dissolved oxygen was high at the surface but low just below the thermocline, increasing to 9 ppm at 170 feet. The depletion at 50 feet may have been due to the extensive plankton "bloom" in progress at this time. The pH of the water was alkaline at the surface and bottom (7.5) but slightly acidic at 50 and 100 feet (6.8). This indicates that little organic decomposition is occurring on the lake bottom.

The secchi disc visibility was reduced to six feet by the large number of plankters in the water and also by the brown color of the water.

The conductance of the water (standardized to  $18^{\circ}\text{C}$ ) ranged from 88 to 91 mmhos/cm. This indicates a moderate amount of dissolved nutrients in the water.



Four water samples were taken at the limnology station at different depths on September 9, 1967 (Table IV). The total alkalinity was 50 ppm as  $\text{CaCO}_3$ . The calcium hardness ranged from 25 to 45 ppm while the total hardness varied from 45 to 50 ppm as  $\text{CaCO}_3$ . This water was quite soft.

The limnology and water chemistry of this lake are indicative of low productivity.

#### BOTTOM FAUNA

Fourteen bottom samples were taken with a six inch square Ekman dredge on September 7, 1967. The samples were washed through a screen bottomed bucket (25 meshes per inch) and all living organisms were preserved.

All the dredgings (except the shallow one at one foot) contained organic muck, with organic detritus evident at 30, 35, 51 and 69 feet (Table II). There did not appear to be a great accumulation of organic ooze on the bottom, since the echos on the depth recorder were quite distinct. Most of the shore is of sand or gravel, with little, if any, mud. Aquatic emergent and submergent vegetation was evident along all the shores, at least within the 0 to 10 foot contours.

An average of 3014 organisms per square meter was found, with a volume displacement of 13.68 c.c. per square meter. The bottom fauna was dominated by chironomids at all depths. Oligochaetes were next in abundance, followed by pelecypods (all sphaeriids). All other organisms were insignificant in number and volume (see Figure 4). It may be noted that no Pontoporeia were found in the samples.

## PLANKTON

Vertical plankton hauls were made with a Wisconsin type plankton net (mouth diameter of 20 cm.) at the limnology station on September 9, 1967.

The blue-green algae dominated the phytoplankton, with the most abundant genus being Anabaena, while Coelosphaerium and Microcystis were also abundant. The diatoms were very abundant, particularly Melosira, Tabellaria, Fragilaria, Stephanodiscus and Asterionella. These plankters are commonly found in lakes of low productivity. The green algae were represented by four species: Spirogyra, Gymnozyga, Pediastrum and Staurastrum, with only Staurastrum being found in any abundance (Table V).

The zooplankton was dominated by copepods (both adults and nauplii), with cladocera and rotifers being common. Only a small portion of the net plankton was zooplankton.

## FISH FAUNA

Gill nets of mesh sizes ranging from  $1\frac{1}{2}$  to  $5\frac{1}{2}$  inches (stretched measure) were set on September 7, 1967 and lifted the following morning. All nets were 100 yards in length except the  $1\frac{1}{2}$  inch mesh net which was only 50 yards in length.

The fish caught included walleye (Stizostedion vitreum), northern pike (Esox lucius), perch (Perca flavescens), burbot (Lota lota), lake whitefish (Coregonus clupeaformis) and tullibee (Coregonus artedii) (Table VI).

The most abundant species in the catch was lake whitefish,

being caught in  $1\frac{1}{2}$ ,  $2\frac{1}{2}$ , and  $3\frac{1}{2}$  inch mesh. A few walleye, northern pike and perch were caught in the shallow water ( $1\frac{1}{2}$  and  $2\frac{1}{2}$  inch mesh). Tullibee were caught only in the  $2\frac{1}{2}$  and  $5\frac{1}{2}$  inch mesh.

The absence of lake trout in the nets may not necessarily indicate their absence in the lake. However, lake trout have never been reported from this lake and they are not usually associated with such brown water.

The walleye and northern pike are probably more abundant in the west and southwest end of the lake, which is the shallower portion.

#### Walleye

Seven walleye were examined, the fork length, weight, sex and maturity of each being recorded. Scale samples were taken for age determination. These fish ranged in age from two to five years, and all were immature. They appear to be quite slow growing; as the largest one was 385 mm. in length and weighed 650 grams (Table VII).

#### Northern pike

Eleven northern pike were examined, the fork length, weight, sex and maturity of each being recorded. Scale samples were taken for age determination. These fish ranged in age from four to eleven years and appeared to mature in their sixth year. The largest was 905 mm. in length but weighed only 3820 grams (Table VIII). These fish appear to be quite slow growing and have a very thin appearance. This may reflect the oligotrophic nature of the lake.



### Perch

Nine perch were examined, the fork length, weight, sex and maturity of each being recorded. Scale samples were taken for age determination. These fish ranged in age from three to five years, the heaviest one weighing 60 grams (Table IX). These perch are very slow growing and the species is probably of little importance in the lake.

### Tullibee

Seven tullibee were examined, the fork length, weight, sex and maturity of each recorded. Scale samples were taken for age determination. They ranged in age from four to six years and were all quite small (120 to 170 grams), although all were mature (Table X). There is probably a fair number of tullibee in this lake, although they were not caught in the nets, as this lake has a fairly extensive limnetic area.

### Lake whitefish

Seventy-five lake whitefish were examined, the fork length, weight, sex and maturity of each being recorded. Scale samples were taken for age determination. These fish ranged in age from one to eight years. They appear to be very slow growing and at seven years of age are just over one pound in weight (Table XI, Figure 6). Very few of these fish were mature, most probably not spawning until their eighth year. There appears to be adequate spawning habitat for the species.

Twenty of these fish were examined for plerocercoids of Triaenophorus crassus. Nineteen (95%) were infected with a total of



225 cysts. The total weight of the twenty fish was 14.47 pounds, which gives a rate of infestation of 1555 cysts per 100 pounds of fish.

Due to their small size and high infestation with Triaenophorus crassus, the lake whitefish from this lake have little commercial value. Their poor growth rate probably reflects the oligotrophic nature of this lake.

#### DISCUSSION AND CONCLUSION

Using the morpho-edaphic index of Ryder (1965), a total annual production of 2.5 pounds per acre is postulated, which represents a total of 8750 pounds per year. Most of this would be in the form of lake whitefish or tullibee, which have little commercial value in this lake. Some northern pike and walleye production could be expected, but as these fish are quite small and slow growing, they would have little value as a sport fishery.

As a result of the oligotrophic nature of this lake, it has little value as either a sport or commercial fishery.

TABLE I. Morphometry of Unnamed Lake (100-15-W4th M).

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LOCATION: Twp. 100, Rge. 15, W. 4th M.

AREA: 5.39 square miles (3450 acres)

VOLUME: 178,000 acre feet

SHORELINE: 12.5 miles

SHORELINE DEVELOPMENT FACTOR: 1.5

MAXIMUM LENGTH: 5.1 miles

MAXIMUM EFFECTIVE LENGTH: 5.1 miles

MAXIMUM WIDTH: 1.5 miles

MAXIMUM EFFECTIVE WIDTH: 1.5 miles

MEAN WIDTH: 1.1 miles

MAXIMUM DEPTH: 210 feet

MEAN DEPTH: 52 feet

DEPTH DISTRIBUTION:

Surface area:	5.39 sq. mi. (3450 a.)	=	100%	surface area
10 feet plus:	4.60 sq. mi. (2944 a.)	=	85%	surface area
20 feet plus:	4.05 sq. mi. (2592 a.)	=	75%	surface area
30 feet plus:	3.39 sq. mi. (2170 a.)	=	63%	surface area
40 feet plus:	2.81 sq. mi. (1798 a.)	=	52%	surface area
50 feet plus:	1.55 sq. mi. ( 992 a.)	=	29%	surface area
60 feet plus:	1.32 sq. mi. ( 845 a.)	=	25%	surface area
80 feet plus:	0.99 sq. mi. ( 634 a.)	=	19%	surface area
100 feet plus:	0.76 sq. mi. ( 486 a.)	=	14%	surface area
120 feet plus:	0.64 sq. mi. ( 410 a.)	=	12%	surface area
140 feet plus:	0.50 sq. mi. ( 320 a.)	=	9%	surface area
160 feet plus:	0.36 sq. mi. ( 230 a.)	=	7%	surface area
180 feet plus:	0.12 sq. mi. ( 77 a.)	=	2%	surface area
200 feet plus:	0.06 sq. mi. ( 38 a.)	=	1%	surface area

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TABLE II. Bottom fauna from Unnamed Lake (100-15-W.4th M.).  
September 7, 1967.

Sample No.	Depth (feet)	Substrate	Ephemeroptera	Chironomidae	Oligochaeta	Amphipoda	Pelecypoda	Gastropoda	Others	Total No.	Displaced Volume (c.c)
67225	1	sand	1	29	18	9	9	2	1	69	0.60
67232	30	muck	-	19	-	-	3	-	-	22	0.10
67226	35	muck	-	30	-	-	2	1	-	33	0.30
67228	36	muck	-	47	4	-	2	3	-	56	0.60
67227	39	muck	-	26	2	-	2	-	-	30	0.40
67229	48	muck	-	41	7	-	5	-	-	53	0.40
67231	48	muck	-	39	4	-	2	-	1	46	0.20
67230	51	muck	-	53	1	-	5	-	-	59	0.50
67233	51	muck	-	17	5	-	3	-	-	25	0.25
67238	69	muck	-	460	5	-	-	-	-	465	0.40
67235	126	muck	-	20	34	-	-	-	-	54	0.30
67234	168	muck	-	4	7	-	-	-	-	11	0.15
67236	174	muck	-	19	35	-	-	-	-	54	0.20
67237	204	muck	-	1	2	-	-	-	-	3	0.05
Totals			1	805	124	9	33	6	2	980	4.45

TABLE III. Physical and chemical observations, Unnamed Lake  
(100-15-14th M), September 9, 1967.

Depth (feet)	Temperature (°C)	Dissolved Oxygen (ppm)      % saturation		Conductivity (mmhos/cm @ 18°C)	pH (Hellige)
0	15.5	8	80	88	7.5
10	15				
20	15				
30	14.5				
40	14.5				
50	8.5	4	35	90	6.8
60	7				
70	6				
80	5.5				
90	5				
100	5	6	45	90	6.8
110	5				
130	5				
150	5				
170	4.5	9	70	91	7.5
190	4.5				
200	4.5				



TABLE IV. Water chemistry, Unnamed Lake (100-15-W4th M). Four samples were taken on September 9, 1967, at the limnology station.

Sample No.	67089	67090	67091	67092
Depth (feet)	0	50	100	170
Temperature ( $^{\circ}\text{C}.$ )	15.5	8.5	5	4.5
Dissolved oxygen (ppm)	8	4	6	9
Phenolphthalein alkalinity (ppm $\text{CaCO}_3$ )	0	0	0	0
Total alkalinity (ppm $\text{CaCO}_3$ )	50	50	50	50
Calcium hardness (ppm $\text{CaCO}_3$ )	35	35	25	45
Total hardness (ppm $\text{CaCO}_3$ )	45	45	50	50
pH (Hellige)	7.5	6.8	6.8	7.5
Conductivity (mmhos/cm @ $18^{\circ}\text{C}.$ )	88	90	90	91

TABLE V. Plankton from Unnamed Lake (100-15-W4th M). September 9, 1967.

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PHYTOPLANKTON

<u>GROUP</u>	<u>ORGANISM</u>	<u>RELATIVE ABUNDANCE</u>
Cyanophyta	<u>Anabaena</u>	Very abundant
	<u>Coelosphaerium</u>	Abundant
	<u>Microcystis</u>	Abundant
Chlorophyta	<u>Spirogyra</u>	Scarce
	<u>Gymnozyga</u>	Rare
	<u>Staurostrum</u>	Common
	<u>Pediastrum</u>	Rare
Chrysophyta	<u>Melosira</u>	Abundant
	<u>Tabellaria</u>	Abundant
	<u>Fragilaria</u>	Common
	<u>Stephanodiscus</u>	Common
	<u>Asterionella</u>	Common

ZOOPLANKTON

<u>GROUP</u>	<u>RELATIVE ABUNDANCE</u>
Copepoda (adults)	Abundant
	(nauplii) Abundant
Cladocera	Common
Rotifera	Common
Gastrotricha	Rare

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TABLE VI. Test net results, Unnamed Lake (100-15-W4M), September 8, 1967.

Catch Record No.	Duration of set (hrs.)	Depth Fished (feet)	Mesh Size (ins.)							Totals
				Lake Whitefish	Walleye	Northern Pike	Tullibee	Perch	Burbot	
67069	12	10	1½	24	4	8	-	9	-	45
67070	12	20-50	2½	65	3	3	5	-	1	77
67070	12	50-80	3½	31	-	-	-	-	1	32
67071	13	100-120	4½	-	-	-	-	-	-	0
67071	13	120-160	5½	-	-	-	2	-	-	2
Totals				120	7	11	7	9	2	156

TABLE VII. Length and weight of walleye from Unnamed Lake (100-15-W4M), September 8, 1967. Seven fish were examined. All were immature.

Age Class	Number	Fork Length (mm)		Weight (gms)	
		mean	range	mean	range
II+	1	167		50	
III+	3	263	258-270	180	170-190
IV+	1	292		240	
V+	2	332	280-385	445	240-650

TABLE VIII. Length, weight and maturity of Northern pike from Unnamed Lake (100-15-W4th M), September 8, 1967. Eleven fish were examined.

Age Class	n	oo	No. Mature	Fork Length (mm)		Weight (gms)	
				mean	range	mean	range
IV+	1	0	0	440		550	
V+	1	1	0	532		900	
VI+	5	3	4	581	540-618	1308	1170-1440
VII+	2	1	2	600		1385	1320-1450
VIII+	1	1	1	680		2130	
XI+	1	1	1	905		3820	

TABLE IX. Length and weight of perch from Unnamed Lake (100-15-W4M), September 8, 1967. Nine fish were examined.

Age Class	Number	Fork Length (mm)		Weight (gms)	
		mean	range	mean	range
III+	5	148	139-154	42	30-50
IV+	3	158	150-166	50	40-60
V+	1	165		60	



TABLE X. Length and weight of tullibee from Unnamed Lake (100-15-W4M).  
September 8, 1967. Seven fish were examined. All were mature.

Age Class	Number	Fork length (mm)		Weight (gms)	
		mean	range	mean	range
IV	4	214	204-226	130	120-140
V	1	239		170	
VI	2	230	227-233	145	140-150

TABLE XI. Length, weight and maturity of lake whitefish from Unnamed Lake (100-15-W4M). September 8, 1967. Seventy-five fish were examined.

Age Class	n	♀♀	No. Mature	Fork Length (mm)			Weight (gms)		
				$\bar{x}$	$S\bar{x}$	range	$\bar{x}$	$S\bar{x}$	range
I+	8	-	0	157	$\pm 2.1$	150-165	34	$\pm 1.8$	30-40
II+	6	-	0	194	$\pm 4.2$	180-208	91	$\pm 6.1$	45-90
III+	5	1	0	230	$\pm 5.5$	210-240	136	$\pm 7.5$	110-150
IV+	16	9	0	252	$\pm 2.9$	225-285	178	$\pm 7.8$	130-260
V+	16	9	1	297	$\pm 3.9$	272-318	309	$\pm 15.8$	200-400
VI+	17	7	1	323	$\pm 4.8$	295-373	419	$\pm 20.6$	260-600
VII+	5	2	1	342	$\pm 7.2$	320-365	470	$\pm 29.6$	380-560
VIII+	2	1	2	355		346-363	615		550-680



Figure 1. Contours of Unnamed Lake (100-15-W. 4th M.). Depths are in feet. Soundings were taken during the survey and this map constructed from that data.

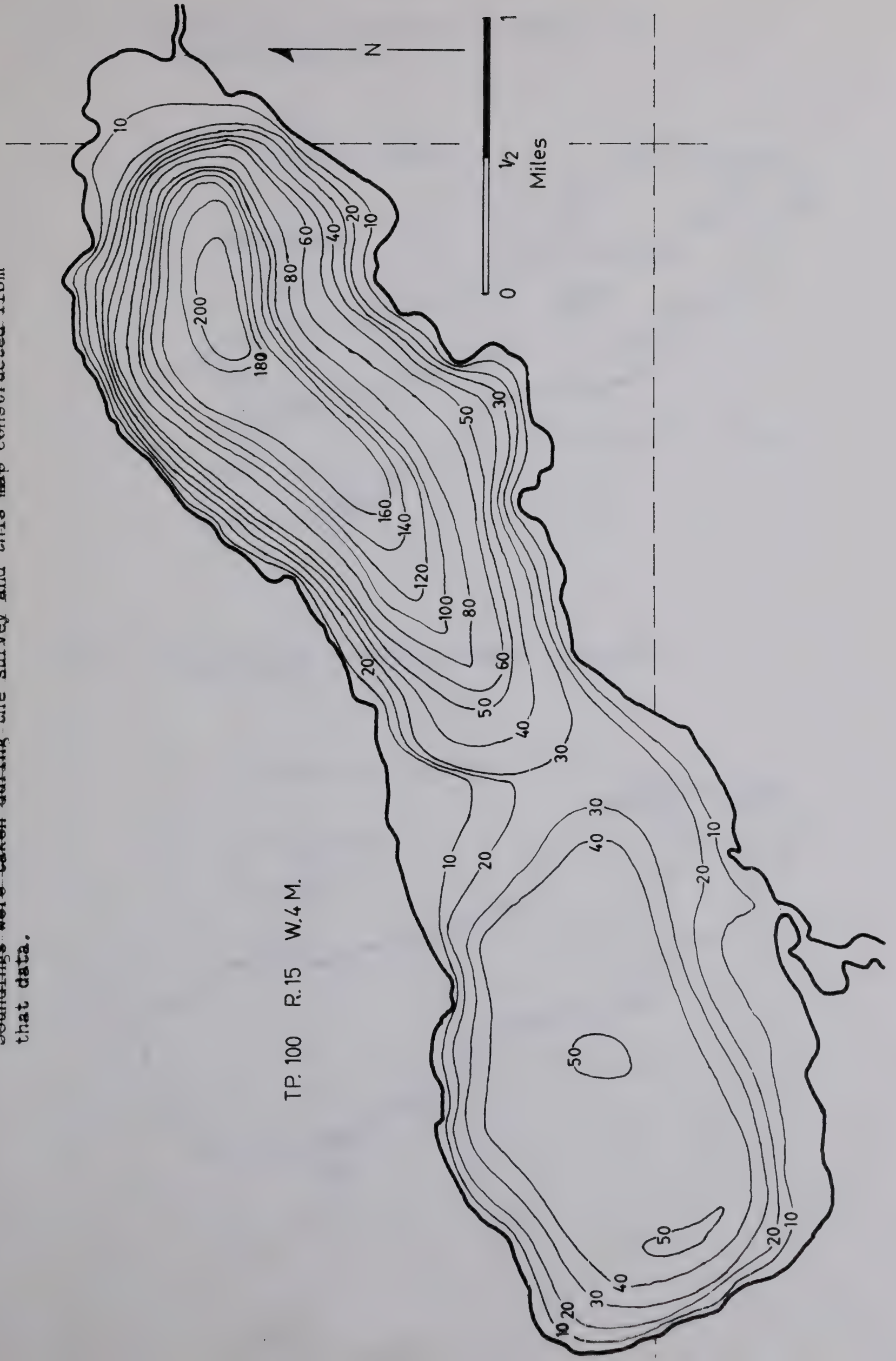






Figure 2. Bottom sampling stations on Unnamed Lake (100-15-W. 4th M.).

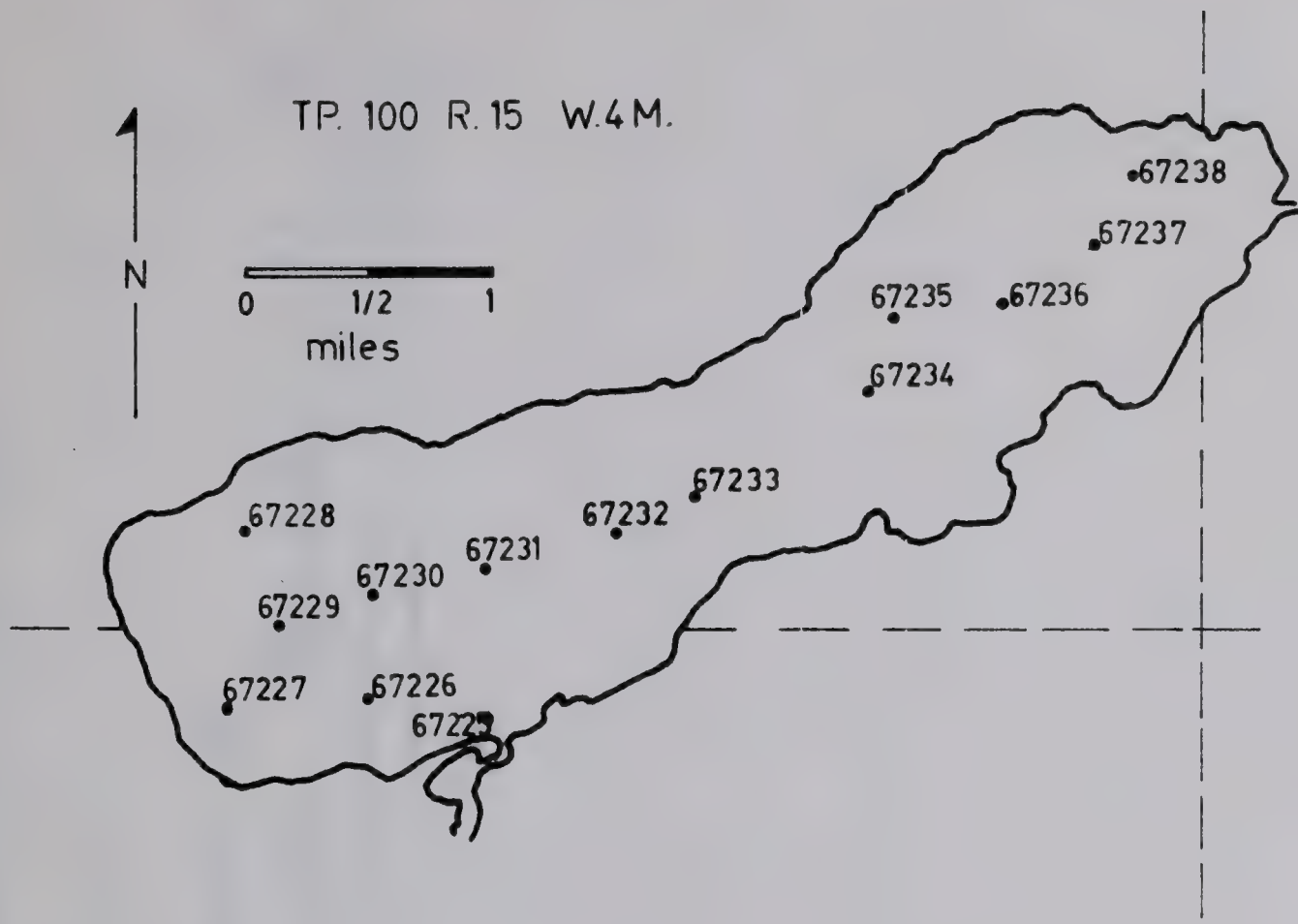


Figure 3. Net sets and limnology station on Unnamed Lake (100-15-W. 4th M.).

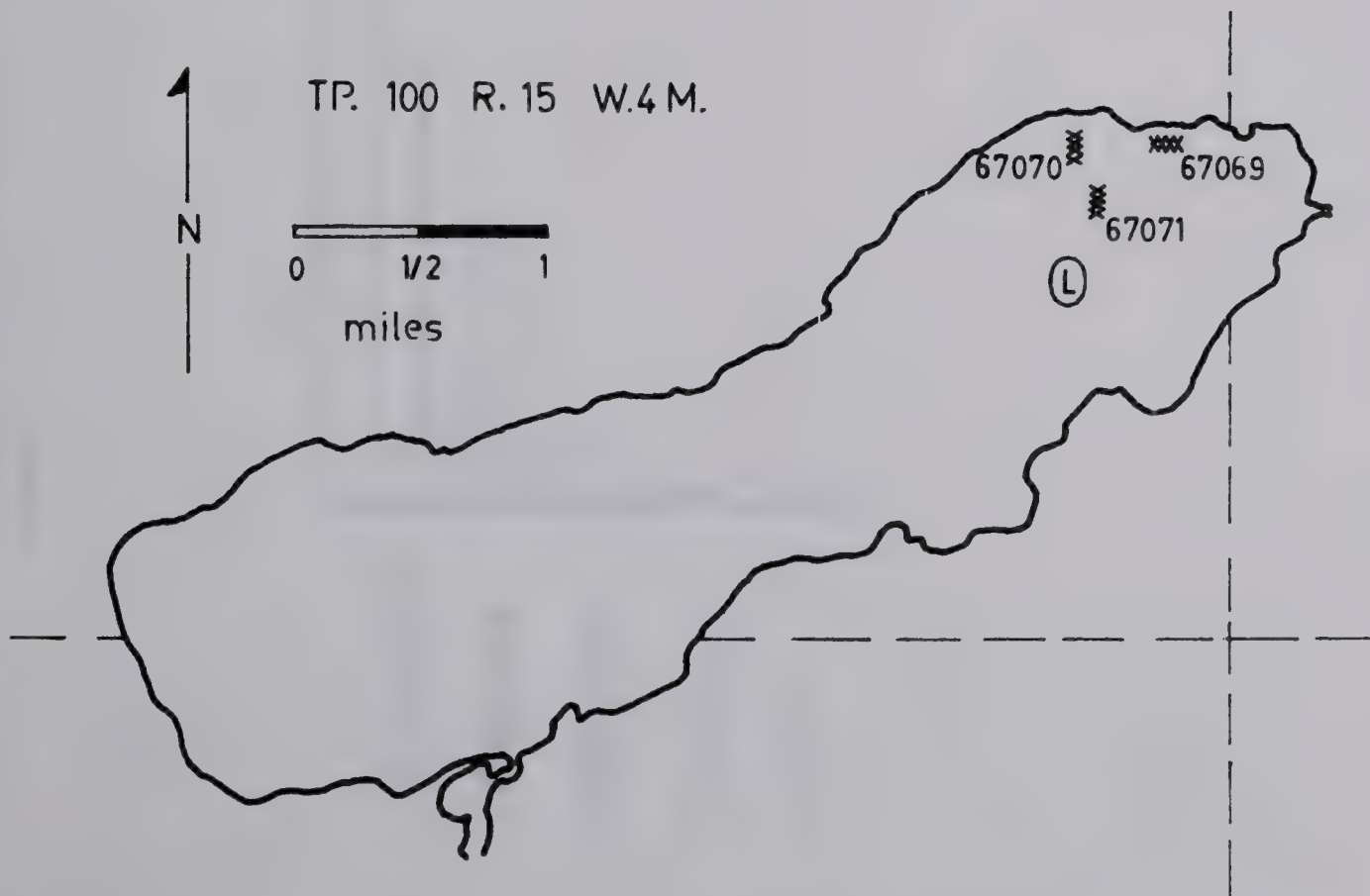




Figure 4. Composition of bottom fauna from Unnamed Lake (100-15-W. 4th M.), September, 1967.

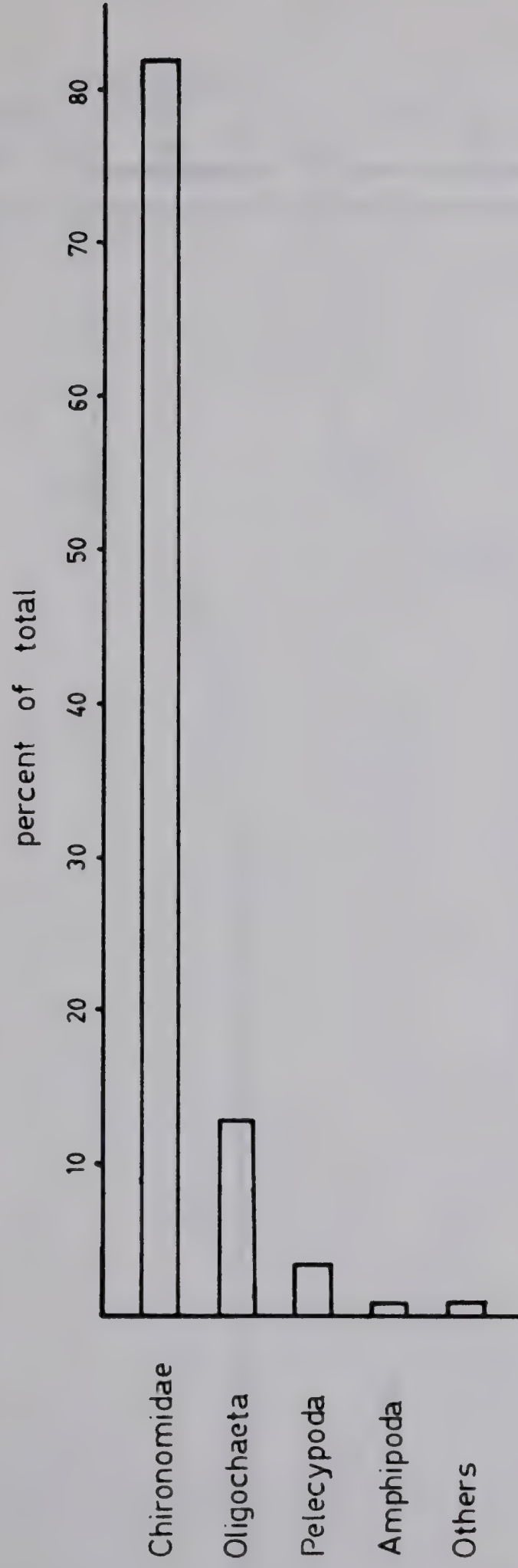






Figure 5. Limnology station on Unnamed Lake (100-15-W. 4th M.), on September 9, 1967.

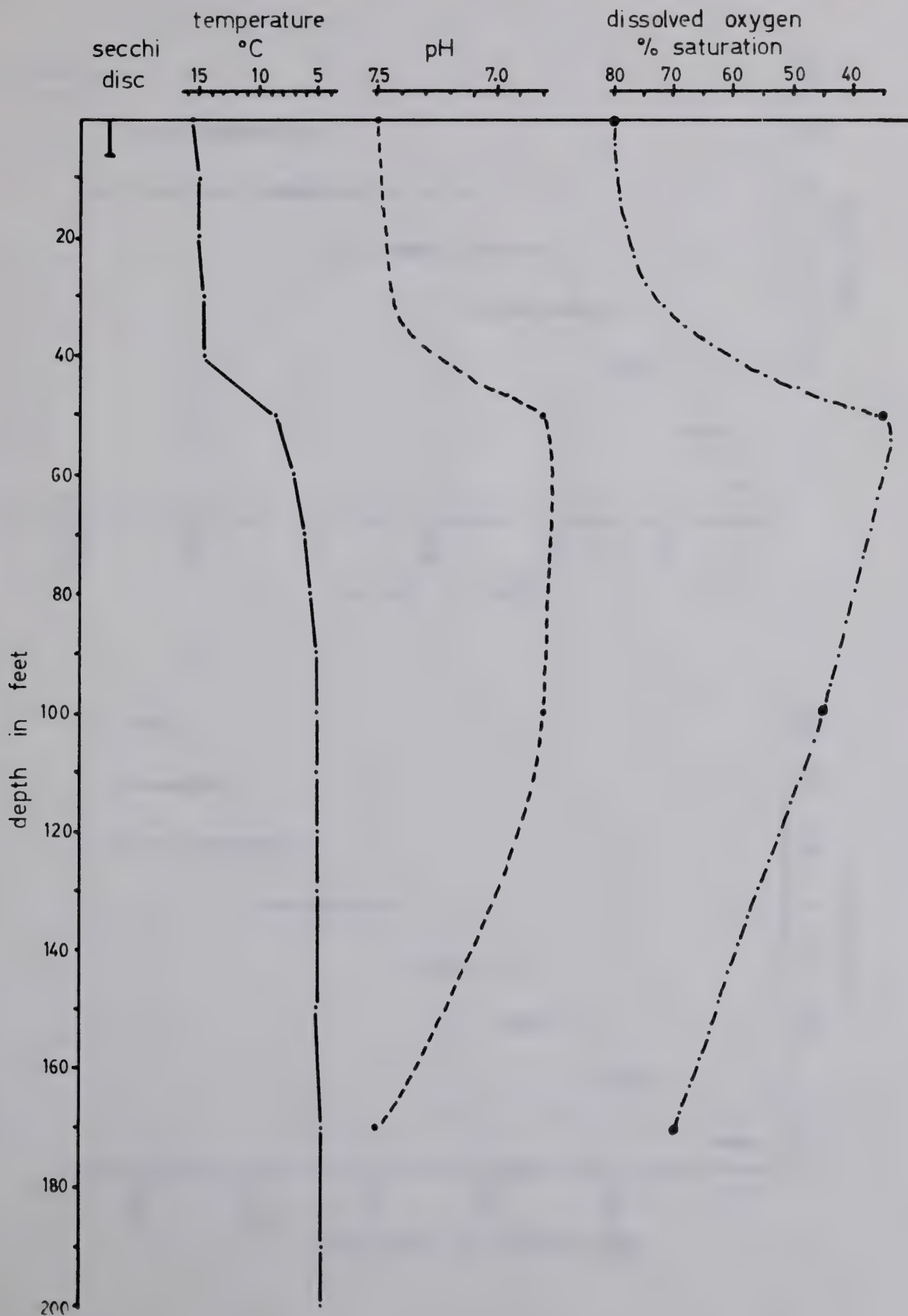
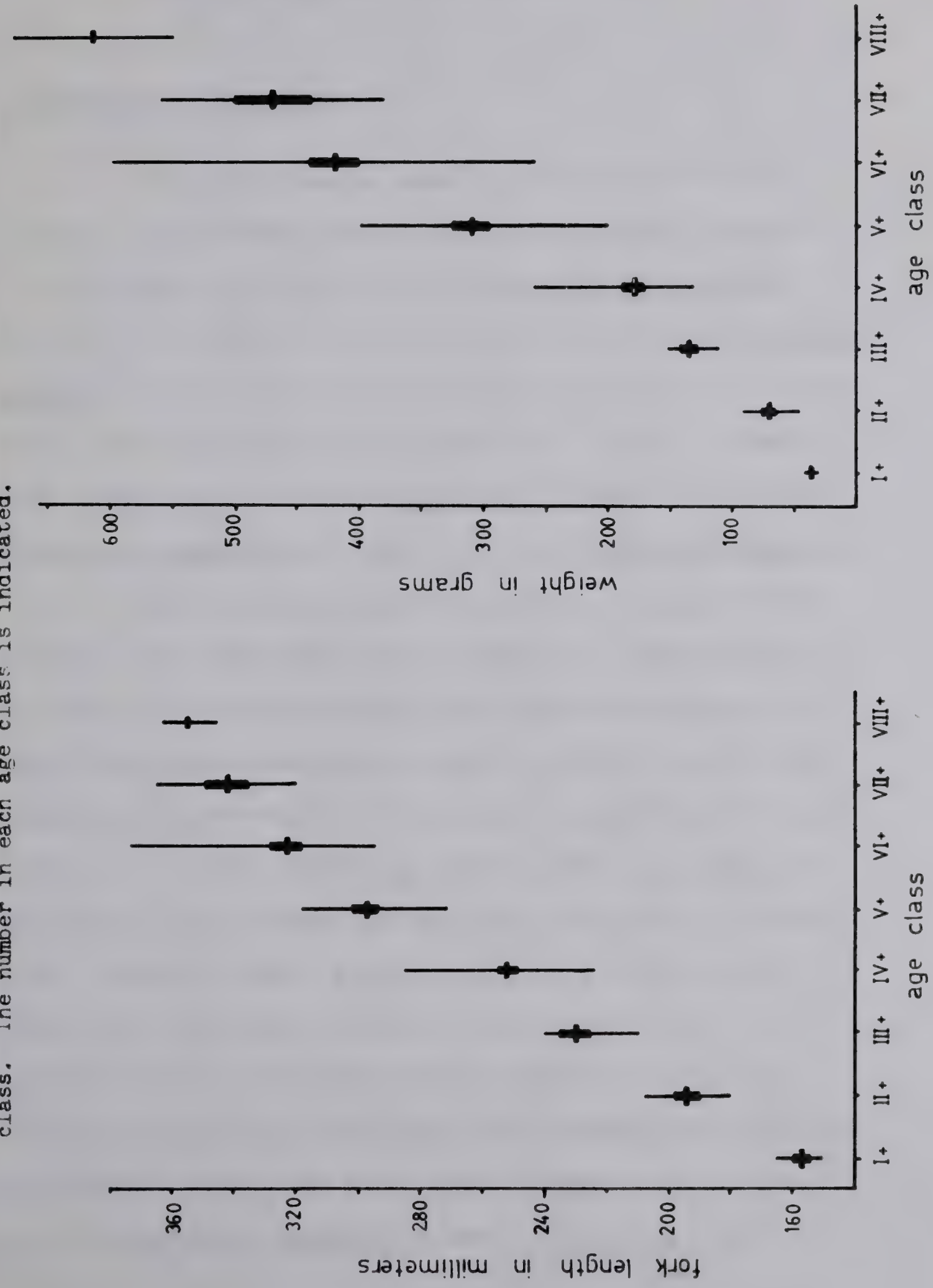




Figure 6. Lake whitefish from Unnamed Lake (100-15-W, 4th M.), September 1967. The figures show the mean, standard error and range in fork length and weight for each age class. The number in each age class is indicated.







A PRELIMINARY BIOLOGICAL  
SURVEY OF WATERS IN THE BIRCH MOUNTAINS

DISCUSSION AND CONCLUSIONS

From the foregoing reports it can be seen that this area has a good fishery potential. The most abundant species of fish is probably the lake whitefish (Coregonus clupeaformis). However, it is heavily infested with plerocercoids of Triaenophorus crassus and as a result has little commercial value in any of the lakes. There are four species of game fish present: Northern pike (Esox lucius), walleye (Stizostedion vitreum), lake trout (Salvelinus namaycush) and arctic grayling (Thymallus arcticus).

These bodies of water can be rated for sport fishery potential and a management policy formulated. The Mikkwa River, at least in the headwater region, has a moderate potential as a fishery for arctic grayling, the limiting factor on this fishery being the low productivity of the stream. Legend Lake has a poor potential as a sport fishery, as the only game fish present in this lake is the northern pike and they do not seem to grow very large. Namur Lake has a good potential for a quality sport fishery for lake trout. Gardiner Lake has a good sport fishery potential due to the northern pike and walleye present which reach very good sizes in this lake. The unnamed lake in Township 99, Range 16, West of the Fourth Meridian has a good potential for the same reasons as Gardiner Lake. The unnamed lake in

Township 100, Range 15, West of the Fourth Meridian has a poor potential for a sport fishery due to its unproductive nature.

The Namur River has a moderate potential, owing to the presence of arctic grayling, the limiting factor here being the small size of the stream. The Ells River probably has a moderate potential for a sport fishery for arctic grayling, northern pike and walleye.

It is evident that a sport fishery in this area must be of the fly-in type due to its inaccessibility. The major attraction would be the lake trout in Namur Lake, although the large northern pike, walleye and arctic grayling in the area would provide other angling opportunities for fishermen.

#### RECOMMENDATIONS

It is recommended that Namur Lake and Gardiner Lake be reserved for a sport fishery. Attempts should be made to encourage the development of a sport fishery in the area. At some time in the future, when the angling pressure is great enough, the unnamed lake in Township 99, Range 16, West of the Fourth Meridian should also be reserved for a sport fishery.

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